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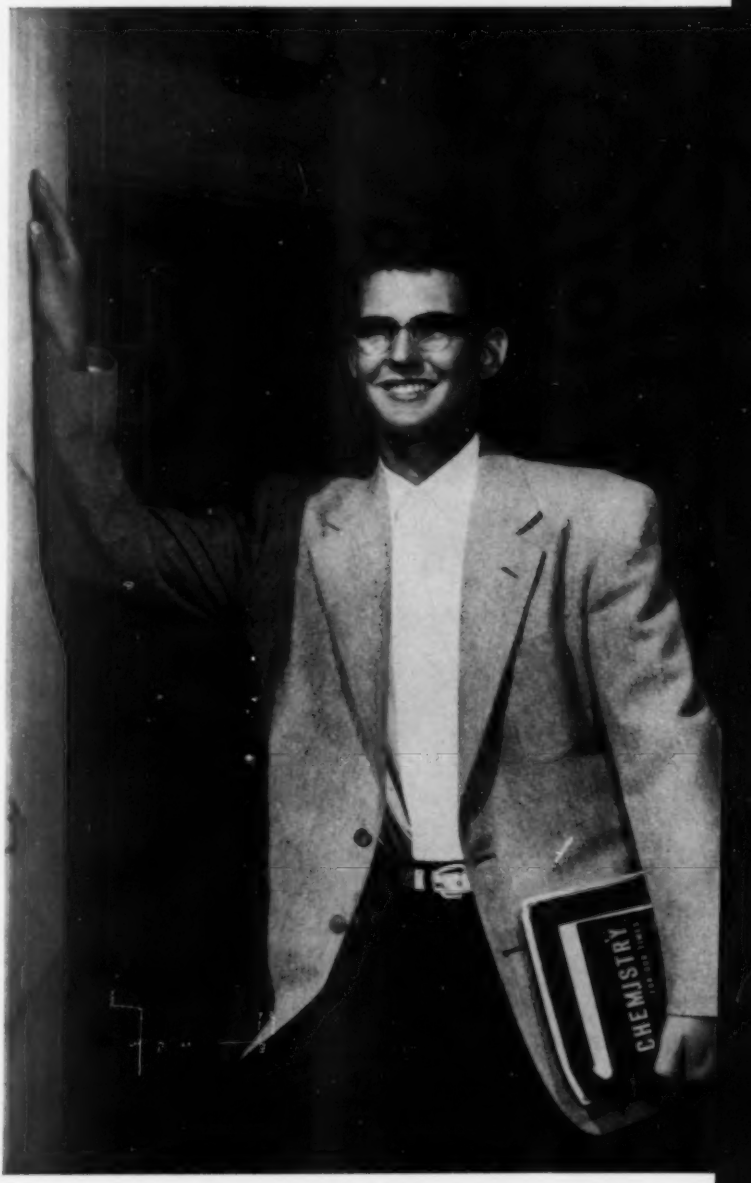

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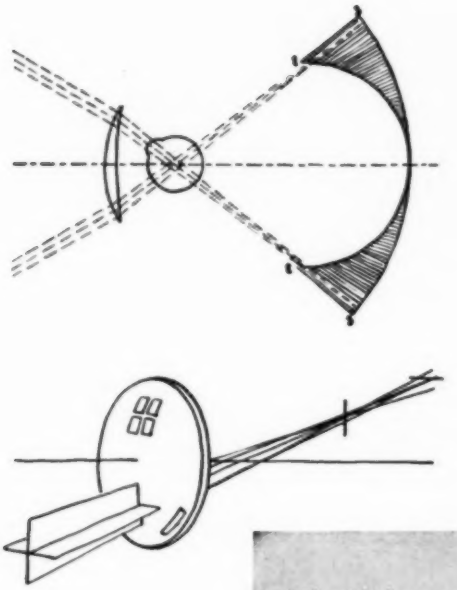

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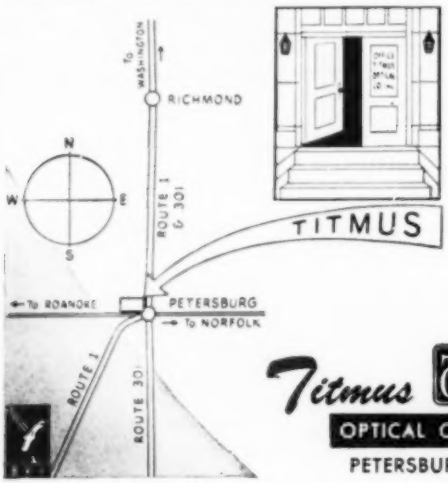

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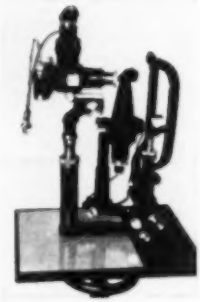

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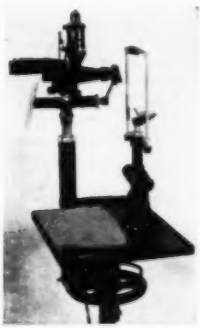

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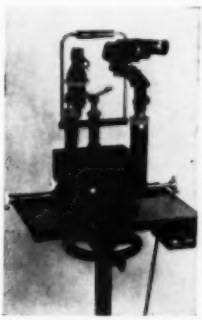

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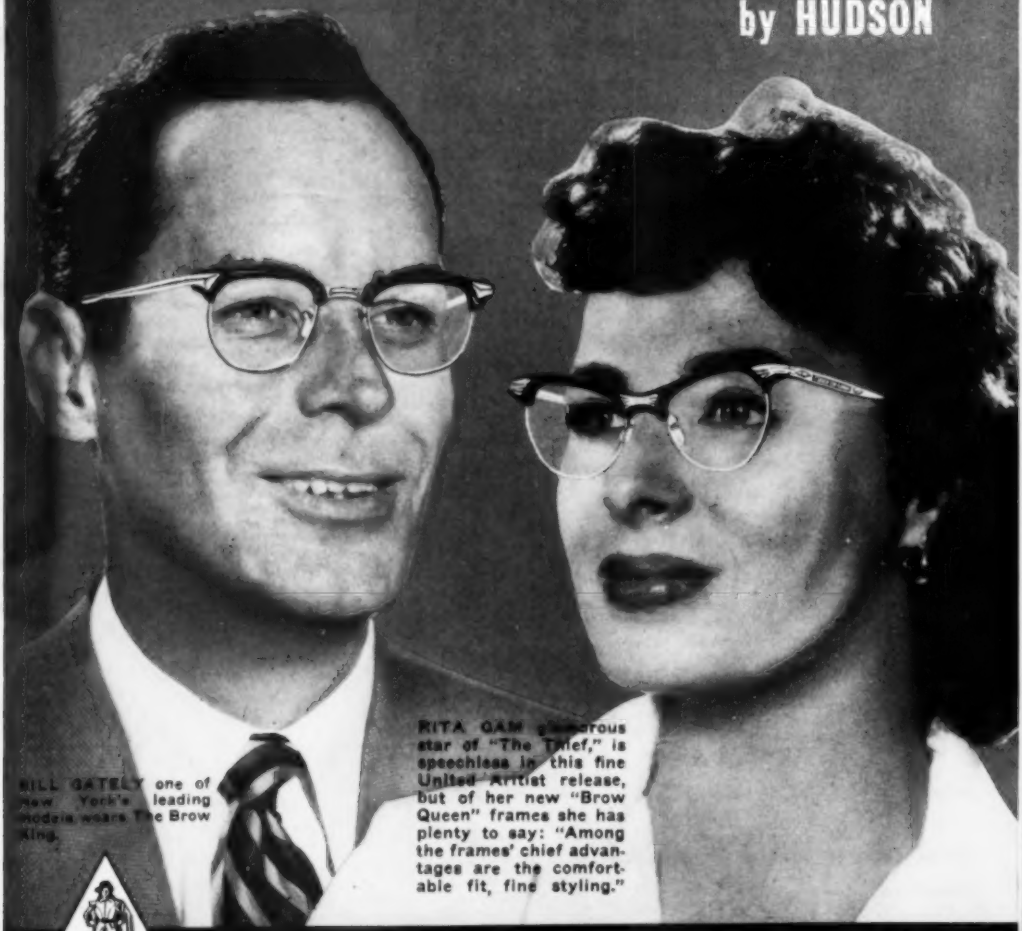

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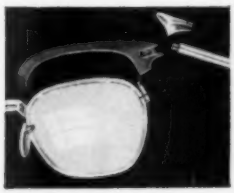

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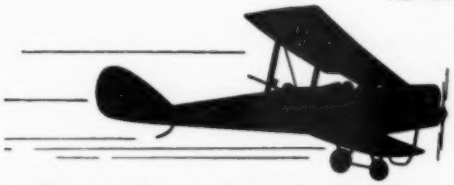

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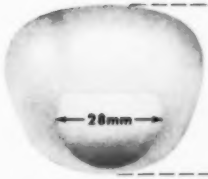

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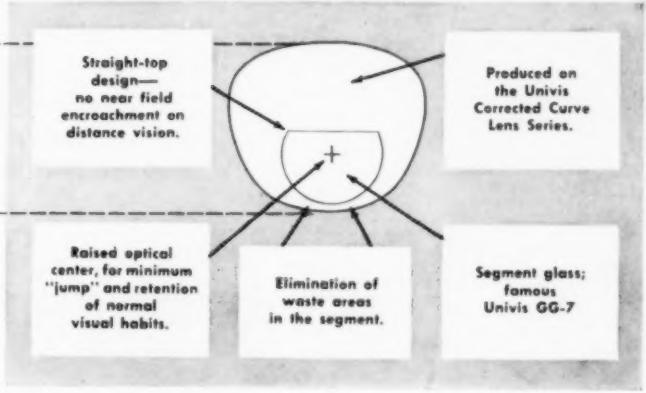
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fig. 1.

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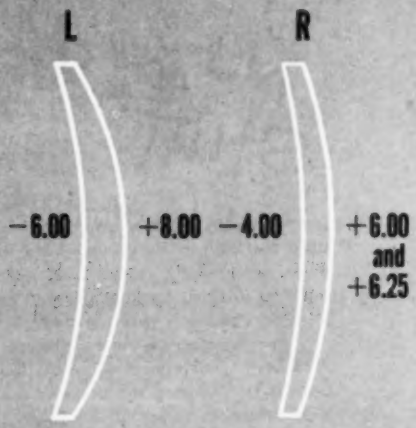

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fig. 2.

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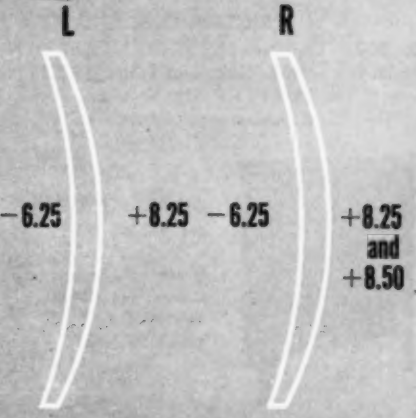

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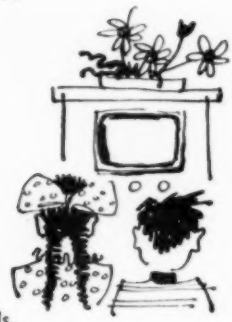

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Vol. 29 October, 1952 No. 10

SPACE PERCEPTION—SOME PHYSIOLOGICAL AND PSYCHOLOGICAL ASPECTS*

Robert E. Bannon†
Southbridge, Massachusetts

(I.) INTRODUCTION: There have been some confusing references in our literature relative to space perception, depth perception, stereopsis, visual manipulation of space, spatial distortions, normal and anomalous spatial localization, etc. The "space perception" that is referred to when speaking of aniseikonia is something different from the same, or similar, expression used with respect to strabismus. Likewise, the "space perception" of a myope or a hyperope presumably refers to something distinctive according to one group but, to another, the term "space perception" seems related to personality patterns. It has also been pointed out that what we have known as heterophoria is but "a disorganization in space perception."

In the field of industrial or occupational vision, and also with respect to motor vehicle operators' vision, there has been reference to an individual having "no depth perception" because he failed to pass a test for stereopsis. The implication seems to be that such an individual would be a hazard to himself and others because he cannot judge correctly the relative position of objects in space.

When one begins to look for information on the subject of "space perception," he may be impressed first—(and that is where he may stop)—with the idea that the judgment of objects in space is solely a psychological matter. On the other hand, one's choice of reading or of the lectures he attends may be such that the physiological aspects of visual perception are stressed exclusively. There are also a few who may be attracted by the recent emphasis on the mathematical analysis of space perception and conclude prematurely that physiological and psycho-

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logical factors can be disregarded. That each of these disciplines (psychology, physiology, mathematics) offer significant and essential facets to the understanding of the role of vision in space perception should be realized by the serious student, and the experienced practitioner.

This paper is an attempt to present briefly some of the salient physiological and psychological aspects of the visual perception of space.

Nativism and Empiricism: One of the most interesting subjects in the field of physiological optics is the phenomenon of visual perception. The question of how a physical stimulus which affects an end organ (receptor) can give rise to a conscious state and result in an awareness of a material object—its color, form, size and distance—has been a subject for discussion for centuries. The ancient philosophers (Aristotle, Aquinas, Suarez) solved the problem to their own satisfaction by reasoning on the data of immediate observation and introspection. However, with the revival in the natural science through the past two centuries, the "experimental method" has become the constant working basis. With the introduction of this technique since the time of Wundt (1859-1911) considerable progress has been made in understanding the nature and the laws of visual perception.

For many years, there have been two opposing schools of thought relative to the fundamental basis of space perception. On the one hand there are the nativists who maintain that the perception of space is an *innate* attribute of the act of vision: that as soon as a person sees objects, he is aware of their relative positions in space. The other school of thought, the empiricists, claim that when a person sees first, all objects, near and far, appear on a flat surface close to the eyes: that subsequently the person *learns* to utilize certain factors and acquires the ability to perceive relative spatial positions correctly.

There have been many experiments, much rational evidence, and considerable discussion in favor of and against both sides. On certain matters, there is a wide gap between the two great schools of visual perception. However, Boring has pointed out that every nativist is something of an empiricist, and every empiricist something of a nativist. It is impossible to determine which theory is right since each invokes different realms of thought. They are both right from their specific points of view. They constitute different views of the same fact, and it is the finiteness of the human mind which limits our verification of reality. Fortunately, it is not necessary to settle the question in order to discuss many aspects of the visual perception of space and to show how certain circumstances, internal and/or external, influence our conception of the relation of objects in space to each other and to ourselves.

(II.) PHYSIOLOGICAL CONSIDERATIONS: The following section outlines the visual reaction system with the emphasis on its physiological foundations and its stimulus-response relationships. The stimuli (light) reaching the peripheral visual organ, the retina, having passed through the physical changes imposed on them by the refractive media, produce physical and chemical changes in the retinal receptors. These changes in turn cause alterations and excitations which are transmitted to the central nervous system and appear in our consciousness as impressions of form, color, and other geometric relations.

This represents what may be called the *sensory part* of the visual process. These events give rise to a whole chain of responses in the motor system of the eyes—in the central and peripheral nervous arrangements and in the internal and external muscles of the eyes. The eyes thus form a sensory-motor unit which may be said to be in the service of the sensory system. The motor apparatus of the eyes has no independent significance. It serves primarily to bring a sharp image of the object under consideration on the fovea and to keep it there by positioning the two eyes relative to each other in such a way that the lines of gaze intersect at the point of fixation thereby insuring and maintaining binocular vision.

These motor reactions are of various types. Briefly, they constitute, aside from the voluntary movements, unconditioned and conditioned reflex motor responses. For example, if the illumination varies, the pupil contracts or dilates. When the head is tilted toward one shoulder, the eyes make a parallel torsional movement in such a direction that the vertical meridians of the retinas tend to remain vertical. These two highly useful motor responses are unconditioned reflexes which can neither be impeded nor produced voluntarily. When a light stimulus reaches the periphery of the retina, the eye turns so that the stimulus impinges on the region of best visual acuity, the foveal region. If the fixated object approaches, the two eyes converge in order to maintain binocular fixation. When the fixation is changed, the two eyes are somewhat dissociated and they make adjusting movements, called fusional movements, in order to attain and maintain binocular fixation. All these movements are for the most part reflex in nature, but nevertheless there is a significant difference between these movements and the reflex movements previously mentioned.

If one is engaged in thought or in concentration upon a certain object, he may not notice an object approaching from the side and may fail to turn his eyes toward it. Convergence, or overconvergence, can be controlled voluntarily and under certain conditions, fusional move-

ments may not be possible. All these eye movements, in contradistinction to the true reflex movements, require the cooperation of the cerebral cortex, particularly the act of attention. Hofmann and Bielschowsky (1900) in their study of the fusional movements of the eyes noted the quasi-reflex nature of the fusional movements. They were also aware that these movements are dependent upon the concurrence of attention. They termed, therefore, the fusional movements as psycho-optical reflexes. At that time, Pavlov's work had just begun. Today, the reflex movements which require the cooperation of the cerebral cortex are designated as "conditioned reflexes."

Recapitulating, then, one may say that all eye movements, other than voluntary, are unconditioned or conditioned reflexes which are performed in the service of the sensory aspects of vision: specifically, in the interest of clear, distinct, binocular vision.

Whenever a retinal element is stimulated by light entering the eye, the stimulus is not only perceived as being of a certain *intensity* (light sense); of a certain *color* (color sense); and of a certain *form* (minimum separable, discrimination of points, form sense), but it is also localized in a certain *direction*. Every stimulation of a discrete retinal area produces a complicated sensation which is localized as to its direction in space. If a retinal area located to the left of the fovea is stimulated, the stimulus is perceived in the right side of the field of vision; and, vice versa, if the stimulated retinal area is located to the right of the macula, the stimulus is localized in the left half of the visual field.

The result of this arrangement is that if an object is imaged on a peripheral retinal area and one's attention is attracted to it, the eye will be turned toward that object. The amount of the movement is gauged by the eccentricity of the stimulated retinal area. The more eccentric the area stimulated, the greater the eye movement. Therefore, it is believed that the retinal elements have a retino-motor value which increases from the fovea to the periphery of the retina. The purpose of this reflex is to bring the object of attention quickly and accurately upon the area of highest visual acuity. There is still greater significance: it is that one must attribute to each retinal element a definite *directional*, or *spatial value*. These directional values are intrinsic qualities of the retinal elements.

However, the directional or spatial values of the retinal elements are not fixed absolutely in space. They are fixed only *relative* to the visual direction produced by the stimulation of the fovea and they change in space with the change in position of the visual direction of

the fovea. Therefore, they are more properly called *relative visual directions.*

The fact that certain retinal elements of the two eyes, for example, the two foveas, have a common visual direction is the basic principle in the physiology of binocular vision. It is known as the *law of the common visual directions.*

Retinal elements which have common visual directions are called *corresponding retinal points;* all others are *non-corresponding* or *disparate* retinal elements. This is one of the most important concepts in binocular vision. It may be restated as follows: corresponding retinal elements are those elements of the two retinas which in binocular vision give rise to the localization of the sensation in one and the same visual direction.

Of special importance is the common visual direction of the foveas. It is designated as the *principal visual direction.* Since the visual directions of the other (non-foveal) elements have only a position relative to the principal visual direction, they determine the orientation of spatial sensations *relative to each other* with the principal visual direction as the direction of reference.

If the retinal elements were distributed symmetrically so that when, by mentally superimposing the right retina upon the left, a pin stuck into any part of the retinas should strike corresponding retinal elements, one could say corresponding retinal elements are those elements which have the same relative position with respect to the fovea. However, this is correct only grossly as can be determined experimentally, namely by horopter data.

The "horopter" refers to the locus of points in space which are imaged on corresponding retinal elements. As stated previously, when two retinal points are stimulated, a directional and a separation value results. It is on these relationships that the empirical determinations of retinal correspondence are based. That is, the position in space of pairs of objects that appear to have the same direction as seen by each eye may be determined empirically. They are measured from some assumed optical or anatomical point such as the mean nodal point or the apex of the cornea.

In a complicated optical system, such as the eye, the positions in space of such projection paths are a series of lines whose intersections lie on a caustic surface and not at a common point. By assuming that these lines are straight lines and pass through a single mean nodal point at fixed distances from the cornea of each eye, their intersections will determine a line in the visual plane—the so-called longitudinal horopter.

This is the classical Vieth-Mueller circle which passes through the fixation point and the mean nodal point of each eye. The empirically determined horopter does not lie on the theoretical Vieth-Mueller circle but is much flatter (Hering-Hillebrand deviation). This difference is attributed to an asymmetry of the retinal elements such that the images formed by the nasal half of the retina are larger than those formed by the temporal half.

Binocular vision is the coordinated use of the two eyes resulting in a single perception of external space and the specific sensation of stereoscopic depth perception. The final perceptual images from the two eyes are said to "fuse" in the brain and through the strength of the fusion impulse all movements of the eyes become coordinated in the process of fixating different points in space.

Stereoscopic vision rests upon the fact that each of the two eyes, by virtue of their separation, sees objects in the visual field from a slightly different point of view. Hence, the two retinal image patterns are slightly dissimilar. The angular separation of the retinal images, arising from two points in space, will be different in the two eyes, if one of the points is farther away from the observer. This difference in angular separation defines a disparity between the images. Stereoscopic depth perception arises by virtue of the disparity between the retinal images: uncrossed disparity is associated with the sense of distance away from the fixated point while objects seen in crossed disparity are seen nearer than the fixated point. The sensation of stereopsis is a specific sensation and depends upon the physiological and anatomical organization of the retinal elements of the two eyes.

(III.) PSYCHOLOGICAL ASPECTS: It is quite apparent to anyone who considers the matter, that vision and the visual reactions are ultimately an affair of the mind. It is not only the image that is registered on the retina or in the occipital cortex that determines the visual reactions. It is the perception that results from all the associative and organizing processes of the mind, some innate and some acquired, that regulates what is seen. As Woodworth puts it: one does not see the stimuli, nor the various clues; he sees the objects themselves. The following section attempts to summarize how this is accomplished.

The borderline between physiology and psychology is rather indefinite and difficult to distinguish. It may seem from purely physiological considerations that what one sees is dependent primarily upon the way in which the visual organ, as a receptor, is stimulated. An object is seen as red or blue depending upon whether the light that strikes the retina is of long or short wave length. An object is seen as large when

the amount of retinal surface stimulated is large. An object is seen as a circle or as a rectangle because the area of retinal stimulation is circular or rectangular in form. An object is seen straight ahead or to the right or to the left depending upon the retinal area stimulated. Our experience confronts us with the knowledge that this is not always true. There is no such simple relation between the nature of the retinal images and what we "see." In many instances, one sees the shape and position of objects in other than their true form and place.

A round table appears circular even when one views it from a sitting position, in which case the retinal images are not circular but elliptical in form. Similarly, a round clock or plate appears circular even when viewed from an oblique angle which causes the retinal images to be oval, rather than round. Looking down a street lined with telephone poles one "sees" that the more distant poles are the same size as the nearer ones even though the retinal images of the more distant poles may be a half or a quarter the size of those of the nearer poles. One perceives correctly in spite of the diminished images. As a man approaches one from a distance of 12 yards to a nearer distance of, say, 6 yards, the observer's retinal image of the approaching man's height, as well as width, doubles and the image as a whole increases four times in size. Nevertheless, one perceives the approaching man to be of constant size. Visual experience coincides with the known size and form of objects rather than with the data supplied by the retina.

Generally, one tends to see objects "as they really are" or more correctly, as he has in the past and in various ways, aided by his other senses, learned them to be.

It is obviously not true, then, that retinal stimulation alone accounts for visual perception in its experienced form. Boring quotes Bishop Berkeley as having said, as long ago as 1709, that "the estimate we make of the distance of objects considerably remote is rather an act of judgment grounded on experience than on sense." Likewise, Helmholtz (1866) stated that the idea of space itself must be developed by experience.

In order to attempt to discover the explanation of how one's visual experience differs from that due to physiological factors alone, one must consider some of the other sensory channels. When an experience includes an element which has not been due to the organ of vision alone, it must be concluded that some other faculty has been operative also.

It was suggested long ago that experiences of distance and depth arose from muscular movements. That is, the way in which one senses the amount of space between himself and an object is to move

the body through space to reach the object of regard. The movement will furnish a given amount of sensation of muscle effort and to varying distances will correspond various amounts of this motor experience. Thereafter, the memory of such effort becomes associated with the visual impressions in the same way that touch or temperature memories become blended with certain images. Expressions such as "a day's journey," "a stone's throw," etc., typify this rationality. Likewise, handling experiences (tactile sense) are basic to visual percepts of the third dimension of physical bodies. This empirical doctrine maintains that the perception of visual space is dependent upon muscular activity and sensations derived from the contraction of muscles and from changes thus produced in various parts of the body. The empiricists claim that if all muscular activity and the memory of such activity were banished, stimulation of retinal elements could never become associated with the conception of space and distance.

While there is general agreement that learning is needed before *accurate* spatial localization in *certain environments* is possible, nevertheless, this does not refute entirely the nativistic doctrine. However, before this matter is discussed further, it will be helpful to review some of the important factors involved in the judgment of distance and of space.

In the perception of distance and of depth one must distinguish between the perception of depth differences, i.e., how much one object appears in front of or behind another, and in the absolute localization by which the actual distance from observer to object is estimated. As mentioned previously, binocular vision through the phenomenon of stereopsis provides the most accurate means of relative depth discrimination. However, stereopsis is sometimes dampened or even negated by a preponderance of certain monocular clues in the environment.

The more important of these monocular clues are:

(a) *Overlay*—by which the images of near objects overlap and tend to hide the images of more distant objects.

(b) *Perspective* — which depends upon the fact that objects of equal size have smaller retinal images when at a distance rather than nearby. An example of linear perspective is the apparent convergence of parallel lines that recede in the distance, viz., railroad tracks. Details of known objects are seen more readily when near rather than when distant. Thus, the size of retinal image related to known size of object provides the clue for estimation of distance.

(c) *Aerial perspective* — through which the edges of objects at a distance are less clear than those nearby. Moreover, the more

distant objects appear bluer (cooler) in color due to atmospheric haze. Near objects appear brighter with more color saturation than do more distant objects.

(d) *Light and shadow* — which give clues as to shapes and relative positions of objects.

(e) *Parallax* — which results from head movements: for the relative alignment of more distant objects less changes in position occur from a given head movement than that which occurs for nearer objects. This clue to depth perception is very strong and the precision of depth estimation by means of it is nearly as great as that of stereoscopic depth perception.

(f) *Height* — whereby objects seen above others are judged to be more distant.

(g) *Accommodation and convergence* — to a small extent, through the proprioceptive sense arising from the focusing and verging muscles of the eyes, these factors may provide a clue for gross differences in distance and depth in near vision.

Although the stimuli from one's environment are imagined on the retinas in two dimensions, much like a picture projected on a screen, one readily perceives the third dimension of depth by virtue of the learned clues, mentioned above, combined with the innate binocular processes of retinal correspondence, local sign and stereopsis. The marvelous influence of experience and adaptability to the environment is illustrated by Stratton's classical experiment. Stratton wore lenses which inverted the entire visual field and, although it required a few days, he became "adjusted" to his new visual sensations so that he was able to localize objects in their proper positions.* Experiments conducted at the Dartmouth Eye Institute, in which the author participated, also showed that a new relationship between subjective (experiential) and objective (physical) space could be learned. These experiments consisted of wearing magnifying (size) lenses which caused a geometric disparity in the relative size of the ocular images resulting in a distortion (tipping) of binocular visual space. This tipping, often as much as 30 degrees, was very apparent at first and caused considerable difficulty in orientation. However, this tipping disappeared in a few days—especially in familiar environment. In an unfamiliar environment the tipping would reappear and, more important, in test conditions where

*This does not mean that Stratton actually saw objects right side up but merely that he was able to behave, or to use his new visual impressions, more in accordance with the actual location of objects in his peculiar field of vision.

perspective clues were eliminated, such as on the horopter apparatus, almost the full amount of tipping could always be measured. These latter facts support the stability of retinal (sensorial) correspondence.

From a clinical point of view, it must not be concluded that because one can adjust his experiences to new conditions, such "compensation" will be comfortable. It is believed that somatic symptoms, as well as such conditions as "conflicts, frustration and fatigue" (Bartley), may be the result of the necessity of establishing a new relationship between one's environment and one's visual perception.

An interesting possibility of understanding further the essence of the visual perception of space is provided by Luneburg's recent (1947) monograph on the "Mathematical Analysis of Binocular Vision." Since Euclid's time (ca. 300 B.C.), a number of properties of actual space have been established by the axioms and postulates of geometry. Nevertheless, many careful experiments have demonstrated that Euclidean geometry gives only an approximate explanation of certain phenomenon in the field of visual space perception. For example, no theory based on Euclidean geometry has explained adequately the results of Hillebrand's "Alley Experiment."

Luneburg has concluded that many phenomena of spatial perception can be explained mathematically by the non-Euclidean hyperbolic geometry of Lobachevski. This may provide a new concept of binocular vision and space perception in that a metric, or "measuring stick" for our visual space sense may be forthcoming.

Fry (1950) has also made use of mathematics to outline the basic principles for relating perceived space to physical space and to show how one can proceed in selecting a set of parameters for describing physical and visual space. Fry treats visual space as Euclidean and his analysis seems less complicated than that of Luneburg.

Boeder has presented and clarified Luneburg's analysis at several recent professional meetings. He, and many others, believe that Luneburg's and Fry's work may prove to be one of the most important theoretical contributions to the theory of binocular spatial perception since the time of Helmholtz. Unfortunately, the mathematical explanations of space perception will not appeal to many because the intricacies of the mathematics necessary are not familiar to the average ophthalmic practitioner.

(IV.) SUMMARY: Vision, one of the five senses, is the means by which one is made aware of his environment. Due to the eyes' optical structure and the retinas, light in varying wave lengths impinges upon the nervous system. The different wave lengths of the incoming

radiations are translated into color differences. The differences in their number is translated into brightness differences.

In monocular vision, the various parts of the environment viewed are assigned particular relative distances to each other in accordance with the observer's knowledge of the relative sizes and distances of other objects within the field of view. In binocular vision, the directional patterns are combined. The disparity or differences between the two patterns provides data from which the three-dimensional spatial values can be assigned to the various parts of the pattern.

The exact nature of these spatial values is determined by the innate corresponding receptors in the two eyes and their inter-connections in the brain. Having translated the given patterns into color value and the spatial relationship, learned by experience, a picture is constructed in consciousness. It is this picture which one sees—rather than reality itself. One is not conscious of the incoming stimuli but of the picture in consciousness which is projected outward into space.

"What an object is" and "where it is" is determined largely by the function of vision. Whether or not one's vision is adequate can be judged by how closely the picture perceived conforms to reality and how successfully it enables one to deal with his environment. The act of seeing, depending as it does upon both *innate* and *acquired* (learned) factors: upon reception, translating, memory, attention, experience, interpreting and projection, is not exclusively a physiological nor a psychological process but is a wonderful synthesis of both these processes.

Since aniseikonia is a *binocular* anomaly characterized by unequal size images, it constitutes an additional disparity to that normally present in binocular single vision. This additional disparity causes incorrect localization of objects in space *as judged by stereopsis*. However, it should be borne in mind that stereopsis is not the only faculty by which we judge the position of objects in space. As pointed out previously, there are many empirical monocular clues which assist, or may even predominate, in determining the relative localization of objects in space.

These points serve to explain why some individuals under certain conditions are not aware of any spatial disturbance despite a significant degree of aniseikonia. When the environment is relatively free from stereoscopic clues, or when the individual is able to suppress stereoscopic clues in preference for monocular clues, no subjective difficulty in spatial localization is experienced. On the other hand, if the surroundings abound with stereoscopic clues, incorrect spatial localization will be experienced by those who have a significant degree of aniseikonia.

It is a rather common clinical experience to have certain patients report various distortions in space perception with their new glasses. These distortions often disappear after the new correction has been worn constantly for a few days. This "adaptation" to normal surroundings indicates that the individual is responding to the learned monocular, rather than to binocular stereoscopic clues. This "adaptation" does not mean that the individual has been able to make a physiological compensation for his aniseikonia or has altered in any way the innate correspondence, or disparity, of his ocular images.

Of practical concern to the ophthalmic practitioner, as well as to his patients, is whether or not the "adaptation," mentioned above, can be made without discomfort and without impairment of efficiency. The fact that this is possible in many cases is attested by practitioners who have had patients with obvious aniseikonia but who acknowledge no discomfort or symptoms of impairment. Likewise, there are patients with significant degrees of ametropia and/or heterophoria who manifest no discomfort or impairment. On the other hand, there is a sizeable group of patients who cannot make the "adaptation" to uncorrected aniseikonia, ametropia and/or heterophoria without symptoms or severe discomfort or inefficiency.

The variations of different individuals in response to the same or similar stimuli are due not only to differences in physical health and emotional stability but, also, to such factors as the nature of the visual environment and the nature of the occupational visual requirements in one individual's case as contrasted to another. In any event, it should be realized that if an individual disregards or suppresses binocular stereoscopic clues, the accuracy of his binocular stereoscopic spatial localization is impaired and there is ever present a basis for conflict between the responses to the monocular and binocular clues which can be troublesome and productive of further symptoms eventually.

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ANNOUNCEMENTS

ACADEMY TO VISIT BAUSCH AND LOMB PLANT

The Papers and Program Committee of the Academy has set aside a portion of the afternoon and the entire evening of Tuesday, December 9, for a special Academy visit to the Bausch and Lomb plant in Rochester. Members should keep this visit in mind in arranging their travel plans to and from Rochester, New York, for the annual meeting in that city. The dates of the meeting are December 6, 7, 8 and 9, 1952. The meeting place, the Seneca Hotel. Applicants for membership should be present on December 5 to meet with the Committee on Admittance. Full particulars of the four day program will be presented in the November issue.

PERCEPTUAL TRAINING FOR SPECIFIC INDUSTRIAL PROBLEMS*

I. CLERICAL OPERATIONS

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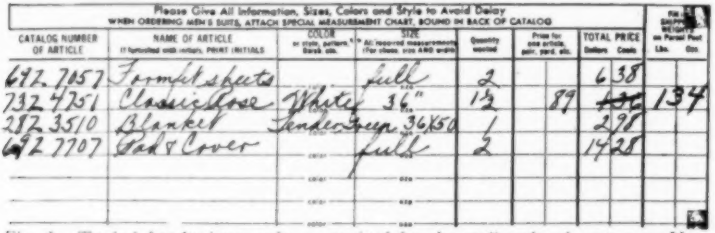
INTRODUCTION

On October 2, 1951, the Institute for Advanced Reading and Perception, as the result of findings on a preliminary survey, began an on-the-job analysis of the visual and perceptual skills required of the employees of the pre-adjusting and billing departments of a large mail order concern in Chicago.



Please Give All Information, Sizes, Colors and Style to Avoid Delay
WHEN ORDERING MEN'S SUITS, ATTACH SPECIAL MEASUREMENT CHART, BOUND IN BACK OF CATALOG

CATALOG NUMBER OF ARTICLE	NAME OF ARTICLE	COLOR	SIZE	Quantity wanted	Price for one article	TOTAL PRICE Dollars	Cents	Lbs.	Ozs.
692 7057	Formfit sheets		full	2		6	38		
732 4251	Classic Hose	White	36"	1½	89	~~4 26~~		1	34
287 3510	Blanket	Tender Beige	36X50	1		2	98		
692 7707	Pad & Cover		full	2		14	28		

Fig. 1. Typical handwritten order as received by the mail order department. Note correction of total price of second item, one of the functions performed by pre-adjusting clerks.

The pre-adjustment clerks are concerned with checking the customer's order, Figure 1, against the sales slip, Figure 2. Accuracy and speed are of prime importance in this operation.

Of paramount concern with the billers is the skill of accurately and quickly dealing with digital problems.

A gross count of the number of eye movements necessary to check a single item on the customer's order against the sales slip ranged from 14 to 24. Knowing the number of digits and words required to be checked and determining the length of time involved by the use of a stop watch, it was possible to approximate the average span of recog-

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†Director of Institute, B. S. Ed. D. O. S.
‡Institute Associate, M. S., O. D.

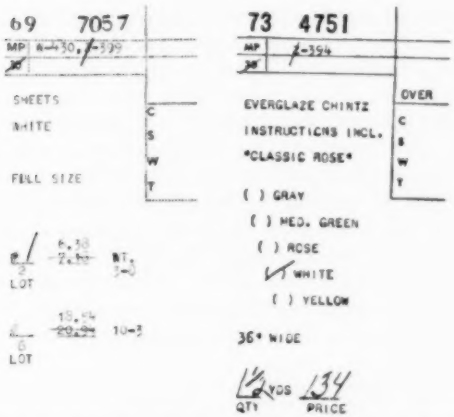


Fig. 2. Sales slips issued by the sales department which must be checked against each individual item on the customer's order. Slips reduced to one-half normal size.

nition and average duration of each fixation. However, to further verify these gross findings, the ophthalmograph, which photographs the eyes in an actual reading situation, was used. A special problem, Figure 3, was devised, and the employees, including pre-adjusters and billers, were selected as subjects. The results of this preliminary test are shown in Table III.

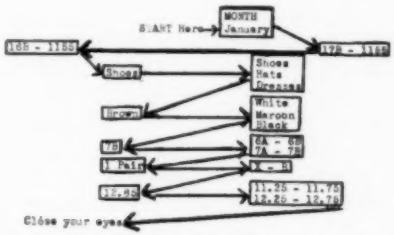


Fig. 3. Preliminary ophthalmographic problem designed to determine speed of recognition, span of recognition, fixations, time, regressions and comprehension.

Completion of the job analysis indicated that the number of eye movements and fixations could be reduced by increasing the span of recognition, i.e., the awareness of peripheral stimuli as individual entities and as groups. The process of "grouping" is a complex function of the nervous system and the muscles or effector organs of the body. It is a skill which can be developed and improved by practice.

The job analysis also provided evidence that increased efficiency could be achieved by increasing the speed of recognition, i.e., shortening the duration of each fixation and reducing the number of regressions.

The hypothesis was formulated that by the establishment of new visual behavior patterns, first integrated on a cortical level and later relegated to a subcortical or reflex level, eye strain and general body fatigue due to this cause could be considerably lessened.

It should be noted that this mail order house has a standard production level which has been calculated for each department. The standard is 100 per cent and is based on the completion of a given number of units per hour. A bonus system provides for increased remuneration where the standards for achievement are exceeded. This factor was psychologically effective in providing strong motivation.

THEORETICAL CONSIDERATIONS

At the Ohio State University, Renshaw[1] has shown that with tachistoscopic training there is a significant and large increase in the form-field of the two eyes. The form-field is defined as the solid angle within and beyond the region of the anatomical macula in which an observer is able to see shapes. Form is a highly complex sensory-cerebro-motor process which usually operates at a low point of efficiency in the untrained. Renshaw was able to increase the total form-fields from four to six times that shown previous to training. The value of increased form fields for the clerical employee is obvious.

For the attainment of the maximum skill in the visual perception of forms, wholes must be seen rather than a succession of discrete and disjoined parts. Brief exposure is one method of forcing the perceiver to see shapes coherently and as unities. Skill in aggregating the sub-units within the total lattice comes with the active effort of making seeing a species of handling response. The motor or effector processes thus come to transform the sensory impression patterns into a more stably structured field, that is, the motor processes react upon the sensory in such a way as to level out, wholly or partially, those differences of excitation which oppose the tendency to equilibrium.[2, 3, 4]

With tachistoscopic training there is a transformation analogous to or possibly identical with the change of the tension movements characteristic of low orders of manipulatory skills to the fluent, accurate, and effortless ballistic movements of the virtuoso. This type of training is not a mere memory process dependent principally on the frequency of impression. Sheer repetition alone is incapable of producing the reorganization of the act of perceiving shapes which leads to high order of skills.[5]

It is quite common for observers early in the course of tachistoscopic training to reproduce all digit components correctly but with inversions and other errors of position. The formal process is more fundamental than the mere mastery of content. The achievement of perceptual skill involves the establishment of a frame of reference into which the content is fitted, with whatever degree of success conditions permit. Anything which disturbs this frame of reference, which is essentially motor in character, inevitably results in error.[6]

Thus the tachistoscope provides a method whereby the subject is trained to complete the visual impression at 1/100 of a second, eliminating the need for vocalization and thereby eradicating an erroneous behavior pattern. This is followed by reorganization resulting in greater efficiency attained by a reduction in the number of errors, fewer regressions and less eye fatigue.

Sherman[7] reports that it is a psychological fact that, if a person looks attentively at an object without moving his eye, he will see it as a perceptual unit. If one is exposed to an object for so short a time that his eyes cannot move, he is automatically required to see it with perceptual unity. This was one of the fundamental concepts utilized in the training.

It is interesting to know that this same principle applies to art: Rembrandt mentions the seeing without eye movements, when he reports that he "learned to see" in his father's windmill, where the interior of the mill was seen under a "flash illumination" caused by the rotation of the blades of the mill as they swept past the window.[8]

The application of perceptual testing in industry has been evaluated by Industrial Psychology, Inc.[9] Of 10 basic mail order jobs studied, and of 12 tests used, the tests measuring perception aptitude correlated most significantly with clerical jobs. Improvement, then, would be anticipated from a perceptual training program.

By stimulating large areas of the retina with the kaleidoscope the observer learns to become more conscious of peripheral retinal stimulations and simultaneously the brilliant multicolors of the projected pattern seem to produce a state of euphoria.[10]

SUBJECTS

A total of 16 subjects was selected by the management. Of this number 12 were pre-adjustment clerks and four were billers. A member of the personnel department participated in the training sessions as an observer.

The group was representative of the departments involved in that the individuals varied from substandard to superior in percentage output and were employed from a period of three months to 10 years.

PRELIMINARY TESTING

Each member of the group was given an initial battery of diagnostic tests to determine the level of starting skills. The battery of tests is described in Table I.

Failure to pass any one of the visual skills necessitated an analytical ocular examination.

The visual analysis provided the following information:

1. The presence or absence of ocular pathology.
2. The need of an ophthalmic prescription.
3. The need for a change in the present prescription.
4. The need for visual training.
5. The combination of the above.

The preliminary procedure in the analytical ocular examination consisted of taking a case history and an external ocular inspection. The analytical ocular examination included the following:

1. Ophthalmoscopy
2. Ophthalmometry
3. Habitual lateral phoria—distance
4. Habitual lateral phoria—near
5. Static Retinoscopy
6. Dynamic Retinoscopy at 20 inches
7. Subjective
8. Induced lateral phoria through subjective—distance
9. True Adduction
10. Convergence
11. Abduction
12. Vertical phoria and ductions through subjective—distance
13. Induced lateral phoria through subjective—near
14. Unfused cross cylinder
15. Induced phoria through unfused cross cylinder
16. Fused cross cylinder
17. Induced phoria through fused cross cylinder
18. Positive relative convergence
19. Positive fusional reserve
20. Negative relative convergence
21. Negative fusional reserve
22. Vertical phoria and ductions—near
23. Amplitude of accommodation
24. Positive relative accommodation
25. Negative relative accommodation

The analytical findings showed that seven of the subjects were either in need of a prescription for the first time, or required a change in their prescription. Visual training was recommended for four of the subjects. However, due to the distance from the clinic and the time that would be involved with orthoptics, it was deemed advisable to suspend this facet of the program.

Ophthalmograph—In addition to the ophthalmographic problem which was given as part of the job analysis, a standard reading test consisting of 100 words was administered to each subject. The use of the ophthalmograph made it possible to determine the number of

TABLE I

VISUAL SKILLS*

Identification	Lateral Balance	Far Point Vision O.D.	Far Point Vision O.S.	Far Point Vision O.U.	Depth Percep.	Near Point Lateral Balance	Near Point Vision O.U.	Near Point Vision O.D.	Near Point Vision O.S.	Fusion	Hand-Eye Coordination**
1.	ortho	20/28	20/17	20/17	50%	7 xo	20/17	20/18	20/17	Failed	Satisfactory
2.	2 eso	20/15	20/15	20/15	70%	ortho	20/17	20/17	20/17	Passed	Satisfactory
3.	2 xo	20/100	20/40	20/40	60%	14 xo	20/20	20/25	20/20	Failed	Unsatisfactory
4.	½ xo	20/22	20/22	20/17	70%	6 xo	20/22	20/40	20/22	Failed	Satisfactory
5.	Unable to determine - Poor acuity	20/100	20/100	20/100	0	9 xo	20/17	20/18	20/20	Passed	Satisfactory
6.	5 xo	20/15	20/15	20/15	70%	8 xo	20/17	20/18	20/22	Passed	Satisfactory
7.	2 eso	20/28	20/60	20/28	70%	4 xo	20/20	20/22	20/20	Passed	Satisfactory
8.	1 eso	20/40	20/22	20/20	70%	4 xo	20/17	20/17	20/20	Passed	Satisfactory
9.	2 xo	20/15	20/15	20/15	30%	6 xo	20/17	20/17	20/17	Passed	Satisfactory
10.	1 eso	20/20	20/100	20/20	70%	6 xo	20/22	20/22	20/33	Failed	Satisfactory
11.	2 eso	20/20	20/20	20/20	0	4 xo	20/20	20/22	20/20	Passed	Satisfactory
12.	ortho	20/40	20/25	20/22	50%	10 xo	20/22	20/25	20/33	Failed	Satisfactory
13.	1 eso	20/20	20/17	20/15	60%	4 xo	20/20	20/17	20/20	Passed	Satisfactory
14.	4 eso	20/20	20/60	20/20	0	ortho	20/20	20/20	20/20	Passed	Satisfactory
15.	1 eso	20/60	20/40	20/40	60%	8 xo	20/20	20/20	20/20	Passed	Unsatisfactory
16.	3 xo	20/20	20/17	20/17	70%	8 xo	20/20	20/20	20/20	Failed	Satisfactory

*All of the subjects had normal vertical balance. All subjects except #16 passed their far point fusion test. Subject #16 showed suppression, and all of the subjects had normal color vision.

**Hand and Eye Coordination was taken on the Keystone 46C Ophthalmic Telebinocular using the A N - 1 card.

eye fixations per 100 words, regressions (going back to re-read) per 100 words, duration of each fixation, span of recognition (number of words seen at one fixation), reading rate in words per minute and comprehension.

Wonderlic Personnel Test—This test was administered to those subjects who previously had not been given the examination by the personnel department. The test is a standardized examination to determine the mental capacity of an individual, specifically designed to serve the needs of business and industry. The normal for the population at large is at the 50th percentile. The mean for this group was 37.5 percentile, with a range in intelligence from the 13.1 percentile to the 76.2 percentile.

EQUIPMENT USED IN TRAINING

The Keystone Tachistoscope was the primary instrument used in the training. It is an overhead projector with an exposure control device similar to that of a camera. Various types of slides described below were flashed on the screen by use of the tachistoscope, at timed intervals beginning at 1/10 of a second, with the exposure gradually being shortened to 1/100 of a second. The slides used were:

Keystone Tachistoscope Series—Basic Forms 1 through 15—Various familiar geometric and common patterns.

Keystone Flashmeter Series—Primary Forms 1 through 15—Various familiar figures frequently observed under environmental conditions.

Configuration Slides—Various patterns developed primarily for the purpose of emphasizing position, size and background.

Keystone Phrase—Sentence Series, Level 1, 2 and 3. Ranges from two word phrases to five word sentences.

Keystone Visual Span Series—Digit slides starting with a span of four digits and progressing to a span of eight. Two types of slides were used—black digits with a yellow background and yellow digits with a black background. The latter type proved the most effective as to number of digits that could be reproduced upon a 1/100 second flash as well as the subjects reported a preference for these slides.

Special slides developed and adapted for the specific operations encountered in the pre-adjusting and billing departments. In view of the fact that the customer's order originates from the catalog, it was decided that the slides must also emanate from the same source. Since the customer's order is invariably in handwriting, the slides were also made up in longhand.

DESCRIPTION OF THE SLIDES

Catalog numbers—handwritten (Figure 4)—generally consisting of two digits (department number), a letter (catalog effort), followed by four digits (merchandise number).

Single Items—Handwritten (Figure 5)—one word items taken from various sections of the catalog.

Two Word Items—Handwritten (Figure 6)—Names of various catalog items consisting of two words.

Three Word Items—Handwritten (Figure 7)—Names of various catalog items consisting of three words.

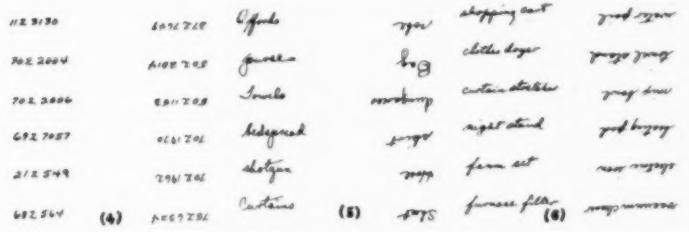


Fig. 4. Slide showing catalog numbers.
Fig. 5. Slide showing one word items.
Fig. 6. Slide showing two word items.

Items and Color—Handwritten (Figure 8)—Name of (one or two words) and color of items taken from various sections of catalog.

Item, Color and Size (Figure 9) Handwritten Name (one or two words), color and size of items taken from various sections of the catalog.

Quantity, Price and Total—(Figure 10) Handwritten—Shows quantity ordered, unit price and total price. The total amount shown may be correct or incorrect.

Kaleidoscope—An optical instrument in which varying rotating

Fig. 7. Slide showing three word items.
Fig. 8. Slide showing item and color.
Fig. 9. Slide showing item, color and size.
Fig. 10. Slide showing price and total.

patterns are shown by reflection in continually changing symmetrical forms.

The company's modern conference room was used for the class sessions. It was approximately 20 feet by 50 feet and contained a blackboard used for illustrating fundamental concepts involved in the training, venetian blinds which covered the four windows were overlaid with draw drapes which eliminated all extraneous light. Illumination during Tachistoscopic training was provided by two 40 watt red bulbs, enclosed in a translucent globe, and located above and slightly behind the subjects.

PROCEDURE

The training program was started on Tuesday, January 8, 1952. Two classes were formed with eight subjects in each group. The limited numbers in each class provided opportunity for observation of individual progress, as well as personal instruction, which proved very helpful in overcoming specific individual stumbling blocks. At the same time the group was large enough to maintain an atmosphere of friendly competition which was a constant source of impetus for achievement.

It was decided the classes should be held in the morning to eliminate the fatigue factor frequently encountered in afternoon or evening training sessions. Each class was given one hour of training daily, the first group beginning at 9:30 A. M. and the second at 10:30 A. M. The project was concluded on February 8, 1952, providing a total of 24 hours of perceptual training.

At the opening of each session a five minute lecture was given on pertinent subject material as listed below:

Principles underlying the training.
Span of recognition.
Speed of recognition.
Developing skill in grouping and "seeing things together."
Posture.
Laws of learning.
Eye movements and fixations.
Elimination of regressions.
Transference of perceptual training to the job situation.

Following the lecture, the retina was stimulated by use of the Kaleidoscope. The subjects fixated the most central portion of the converging patterns and at the same time were instructed to be very conscious of the designs seen with their peripheral vision.

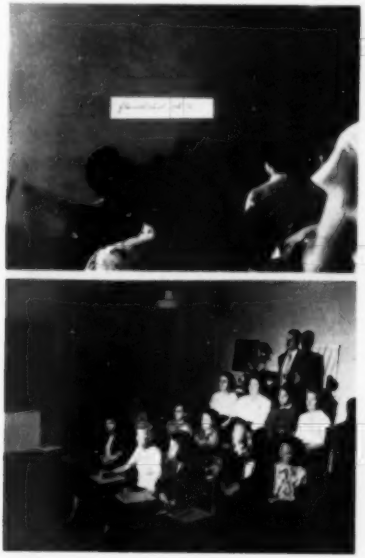
The next twenty minutes were devoted to tachistoscopic training using the basic forms, primary forms, configuration, phrase-sentence series and visual span slides.

To alleviate possible tensions, strain or fatigue, the next five minutes was given for stretching, smoking a cigarette and holding informal discussions. The intermissions provided subjective information which was valuable in directing the program.

After the rest period, the kaleidoscope was again turned on with emphasis on peripheral vision while a relaxed yet alert position was maintained.

The remainder of the time was given exclusively to the special slides produced from numbers, items and prices taken directly from the catalog. This portion of the session always elicited considerable enthusiasm and spirited competition. It was repeatedly stressed and shown how the increased visual span and reduced duration of fixation should be immediately applied to their work upon returning to their desks. The law of learning which states "practice in the manner in which you wish to ultimately perform" was frequently reiterated.

Two typical classroom scenes are shown in Figures 11 and 12. These photos were taken during actual training sessions.



Figs. 11 and 12. (top and bottom) Typical classroom scenes.

TABLE II

PROBLEM OPHTHALMOGRAPH—PRELIMINARY DATA

IDENTIFICATION	COMPREHENSION BEFORE	COMPREHENSION AFTER	FIXATIONS BEFORE	FIXATIONS AFTER	REGRESSIONS BEFORE	REGRESSIONS AFTER	TIME BEFORE	TIME AFTER	AVERAGE SPAN OF RECOGNITION—BEFORE	AVERAGE SPAN OF RECOGNITION—AFTER	AVERAGE SPEED OF RECOGNITION—BEFORE	AVERAGE SPEED OF RECOGNITION—AFTER
1	65	65	28	19	15	4	28.25	11.13	3.58	5.26	1.00	.59
2	70	75	40	20	27	5	30.12	17.00	2.50	5.00	.75	.85
3	70	45	13	9	0	0	11.50	6.00	7.69	11.12	.88	.67
4	75	50	29	18	16	3	18.50	13.50	3.35	5.56	.64	.75
5	55	75	20	15	7	0	15.38	8.50	5.00	6.66	.77	.57
6	85	85	28	33	15	18	18.50	17.88	3.58	3.03	.66	.54
7	70	60	31	22	18	7	20.25	14.35	3.23	4.54	.65	.65
8	85	70	25	19	12	4	21.00	10.13	4.00	5.26	.84	.53
9	70	75	26	15	13	0	21.62	8.50	3.84	6.66	.83	.57
10	75	70	25	9	12	0	25.50	6.75	4.00	11.12	1.02	.75
11	70	50	24	20	11	5	31.17	16.25	4.16	5.00	1.30	.81
12	75	45	19	16	6	1	28.50	21.38	5.25	6.24	1.50	1.34
13	70	90	32	30	19	15	30.00	20.25	3.12	3.33	.94	.67
14	55	80	26	23	13	8	15.50	24.50	3.84	4.34	.60	1.07
15	75	60	24	19	11	4	15.75	15.13	4.16	5.26	.66	.80
16	75	60	25	23	12	8	19.50	16.25	4.00	5.34	.78	.71

RESULTS

To determine the progress of the group, an alternate ophthalmographic problem was devised. It differed from the first in the catalog numbers, items and amounts used. The raw data are shown in Table II.

A statistical evaluation of the raw data is shown in Table III.

TABLE III

PROBLEM OPHTHALMOGRAPH

VARIABLE	MEAN	S.D.	SE MEAN	r (.623—1% level)	C.R. (2.95—1% level)
Before	71.25	8.00	2.07		
Comprehension				—.127	1.28
After	65.938	13.49	3.48		
Before	25.938	5.80	1.50		
Fixations				.522	3.51
After	19.375	6.12	1.58		
Before	12.938	5.80	1.50		
Regressions				.434	4.44
After	5.125	5.09	1.31		
Before	21.94	6.01	1.55		
Time				.264	4.02
After	14.219	5.24	1.35		
Before	4.081	1.13	.29		
Span of Recogn.				.426	3.06
After	5.858	2.21	.57		
Before	.865	.24	.063		
Speed of Recogn.				.460	1.72
After	.7413	.205	.053		

Statistically, as a result of the training, it is shown by the critical ratios that a significant decrease was achieved, at the .01 level, in the length of time required, number of fixations and number of regressions. Also, the critical ratios disclose a significant increase in the span of recognition. The speed of recognition is significant at the .10 level. This may be explained by the fact that a 35.2 per cent decrease in time was accompanied with a 25.3 per cent decrease in number of fixations (an increase in the span of recognition). Thus indicating that the improvement was primarily the result of a decreased number of fixations or in other words an increased span of recognition. Special emphasis was not placed on comprehension nor was comprehension trained *per se*. Therefore, a significant critical ratio was not anticipated.

During the program stress was placed upon increased speed while maintaining the comprehension level. The fact that speed of comprehension, as the result of this procedure, was markedly increased is shown by the results of the ophthalmographic reading problem.

The correlation coefficients are significant at the .05 level (.497) or very close to it with the exception of time and comprehension.

TABLE IV

READING OPHTHALMOGRAPH—PRELIMINARY DATA

IDENTIFICATION	COMPREHENSION BEFORE	COMPREHENSION AFTER	FIXATIONS BEFORE	FIXATIONS AFTER	REGRESSIONS BEFORE	REGRESSIONS AFTER	TIME BEFORE	TIME AFTER	READING RATE BEFORE	READING RATE AFTER	AVERAGE SPAN OF RECOGNITION—BEFORE	AVERAGE SPAN OF RECOGNITION—AFTER	AVERAGE SPEED OF RECOGNITION—BEFORE	AVERAGE SPEED OF RECOGNITION—AFTER
1	60	70	108	86	26	10	28.00	18.00	214	333	.93	1.16	.26	.20
2	100	90	96	108	20	24	26.75	28.00	224	214	1.04	.93	.28	.25
3	90	60	58	54	2	2	16.00	13.00	375	462	1.72	1.85	.28	.24
4	70	90	84	54	16	4	25.25	16.50	238	364	1.19	1.85	.30	.30
5	80	60	84	70	12	6	20.25	18.25	296	329	1.19	1.43	.24	.26
6	80	80	104	110	22	30	23.25	26.00	258	231	.96	.91	.23	.23
7	90	90	72	66	12	10	19.50	19.50	308	308	1.39	1.52	.27	.29
8	70	90	60	56	8	2	20.00	17.50	300	343	1.67	1.79	.33	.31
9	70	90	82	54	12	4	25.25	13.00	238	462	1.22	1.85	.30	.24
10	80	80	92	68	18	8	24.00	17.00	250	353	1.09	1.47	.26	.25
11	80	80	122	78	34	16	34.75	20.25	173	296	.82	1.28	.29	.25
12	100	50	106	72	32	14	30.75	17.00	195	353	.94	1.39	.29	.23
13	90	70	112	82	18	16	29.50	20.00	203	300	.89	1.22	.26	.24
14	70	90	84	62	22	14	23.25	17.75	258	338	1.19	1.61	.28	.28
15	80	50	80	64	6	2	25.25	17.50	238	343	1.25	1.56	.31	.27
16	80	90	84	62	24	14	26.50	17.75	226	338	1.19	1.61	.32	.28

A definite correlation is shown with the time factor but due to changes in the relative positions of some of the individuals it is not as meaningful as for the other variables.

The minus correlation for comprehension may indicate that some of the individuals were performing at a level considerably below their capacity while others who showed a similar level of comprehension were operating closer to limits of their ability. This situation is found in developmental or advanced reading, where the vast majority of adults, regardless of whether or not they have had a college education, read between 250 and 325 words per minute. As the result of reading training some may double while others will triple their previous rates. This may indicate that some individuals, in this particular skill, are performing daily closer to their capacity or potential than others.

It was of considerable interest to the management to find that the group without any specific reading training made a 33 per cent gain in this skill. Since tachistoscopic training expands and enlarges the visual form field, that is the angle within which shapes can be seen clearly and can be identified, an improvement was anticipated. An alternate standard ophthalmographic reading card was given at the conclusion of training, it differed from the first in content. The raw data are shown in Table IV. A statistical evaluation of this data is shown in Table V.

TABLE V

READING OPHTHALMOGRAPH

VARIABLE	MEAN	S.D.	SE MEAN	r (.623—1% level)	C.R. (2.95—1% level)
Before Comprehension	80.625	10.88	2.81	—.305	.819
After	76.875	14.46	3.73		
Before Fixations	89.25	17.45	4.51	.638	3.40
After	71.625	16.99	4.39		
Before Regressions	17.75	8.66	2.24	.626	2.95
After	11.00	7.84	2.02		
Before Time	24.891	4.53	1.17	.357	4.52
After	18.563	3.75	.97		
Before Reading Rate	249.625	48.65	12.56	.377	4.63
After	335.438	62.68	16.18		
Before Span of Recogn.	1.168	.25	.06	.607	3.71
After	1.464	.29	.07		
Before Speed of Recogn.	.2775	.054	.014	.792	1.11
After	.2631	.029	.007		

The critical ratios for the reading material were very similar to the problem ophthalmograph. A significant decrease was achieved in time required for reading, number of fixations, number of regressions and reading rate. A significant increase in the span of recognition was accomplished. Percentages show that reading time decreased 25.4 per cent while fixation decreased 19.7 per cent (an increase in the span of recognition). In the reading as in the problem, the improvement was principally the result of a decreased number of fixations and only secondarily a consequence of increased speed of recognition.

The correlation coefficients for fixations, regressions, span of recognition and speed of recognition are significant at the .01 level. While a correlation is shown for time and also for reading rate, the level is not significant, probably for the reasons postulated previously.

Of paramount concern to management are production figures—on this criteria a program will stand or fall.

TABLE VI

PRODUCTION RECORDS

Identification	Per Cent of Standard Oct.-Dec., Incl. Mean	Per Cent of Standard 2-8-52 - 3-7-52 Mean
1	149	161
2	102	116
3	119	134
4	118	131
5	118	124
6	107	129
7	115	133
8	90	107
9	84	108
10	88	124
11	38	76
12	31	64
13	77	92
14	80	119
15	110	111
16	85	97

The personnel department maintains an accurate production record on each employee. As previously explained, this is calculated on a standard of 100 per cent, which is based on the completion of a specified number of units per hour. Column two, Table VI, shows the average per cent output for each employee during the months of October, November and December, 1951. The third column shows the average per cent of output during the first four weeks following completion of training.

TABLE VII

PRODUCTION ANALYSIS

	Mean	S.D.	S.E. Mean	(.623 - 1% level) r	(2.95 - 1% level) C.R.
Before	94.44	29.10	7.51	.936	6.84
After	114.13	22.86	5.90		

The production analysis, Table VII, shows a highly significant correlation and critical ratio, both at the .01 level of confidence. It is clear, therefore, that this group made significant progress from the standpoint of production. This indicates that the training program achieved its purpose.

CONCLUSIONS

Nine main conclusions may be drawn from the results of this project.

1. A significant increase in production was achieved by the training program.
2. The span of recognition for a specific clerical operation may be significantly increased.
3. The time required for a specific clerical operation may be significantly reduced.
4. The number of fixations required for a specific clerical operation may be significantly reduced.
5. The number of regressions for a specific clerical operation may be significantly reduced.
6. Slides designed for a definite purpose, stimulate interest and provide a more direct and understandable means of transference, from the standpoint of the subject, to a specific job situation.
7. Visual and perceptual training may be specifically designed for a myriad of clerical and industrial situations.
8. Certain intangible personal satisfaction, difficult to measure by usual standards, emerged as beneficial. This included a development of self-confidence which created a more relaxed, less irritable individual able to perform under less tension.
9. Subjectively, a report of less eye strain provided the basis for a feeling of less general fatigue.

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[8]Sherman, Hoyt L., and Ross Mooney, Report on the Visual Training of the Varsity Football Team and the Varsity Basketball Team, p. 2. Columbus, Ohio, Ohio State University, March 1, 1949.
[9]Industrial Psychology, Inc., Job-Tests Program Section I. Chicago, Ill., Industrial Psychology, Inc., 1951.
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INSTRUMENT REVIEW

THE MAGNET-O-GRAPH. George C. Fitzgerrell, O.D., Los Angeles. $12.00.

This instrument is a charting or plotting device consisting of a 17" x 22" heavy gauge steel sheet on which is reproduced the increasingly popular accommodation-convergence graph used for the analysis of clinical optometric findings. Included are fifteen $\frac{1}{8}$" diameter discs which cling by magnetic force to the baked enamel surface of the graph. This ingenious appliance provides for the most rapid and simplest plotting of optometric findings yet designed.

The graph itself is reproduced in heavily ruled black lines for each one diopter interval of accommodation horizontally, and for every five prism-diopter interval of convergence vertically, with finely ruled black lines representing quarter diopter and unit prism-diopter steps. These ruled lines and an overall pastel green background are baked into the smooth enamel surface, assuring easy movement of the magnetic discs over the surface. The total range of accommodation provided for is nine diopters, with a range of 80 prism-diopters for convergence and divergence. The magnetic discs are provided in assorted colors to represent blurs, breaks, recoveries, and phorias. The unit may be attached to the wall or laid on a table for routine use by the optometrist while making clinical tests. The various findings may be recorded directly by pushing the various discs into position without first writing the finding on the examination card.

The unit is sturdy, durable, attractive and professional looking. With the increasing use of graphical methods for analyzing clinical findings this very effective visual aid will meet a real need.

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SUGGESTIONS FOR A NEW FEE STRUCTURE IN OPTOMETRY*

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PART IV‡

A number of interesting and thought provoking proposals relative to the suggestions for a new fee structure were presented in Part III of this report. These comments were made by optometrists of considerable experience who had given the writer's original suggestions some study. In general, they independently found that they agreed with the purpose of the proposal, but they individually differed with one or more of the techniques made in the original suggestions.

For a brief review of the original proposals by the writer, the reader is referred to the outline of them which will be found on the following page.

Most of those who discussed the suggestions were not in agreement with that portion of the plan which recommends that repairs to glasses, which had originally been dispensed by the optometrist, be made at the prescription laboratory cost. While it is a relatively minor point in the entire plan, it seemed to loom large not only to those whose comments were mentioned, but to many other optometrists who have written commendatory letters regarding the overall plan. These writers universally suggested a dispensing fee of from $2.00 to $5.00 for servicing repairs for their own patients as well as for non-patients requesting this service. The proposals of these optometrists are that the amount of the fee should be governed by the time spent by the optometrist in doing the work required.

Certainly there is no reason for not modifying the original suggestion in this manner if one wishes to do so. The change follows the original suggestion in part, as the work is done at the prescription laboratory cost which is collected from the patient, plus a dispensing fee for the service rendered. In reviewing this suggested change in the original proposal, the writer finds *in the dispensing fee for repairs* the

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‡Part V of this report will appear in the November issue. Part I appeared in the July issue, Part II in August, and Part III in September.

OUTLINE OF SUGGESTED FEE STRUCTURE

The author has proposed a simplified fee system for optometrists in professional practice. A minimum examination and refraction fee of $10.00 or more is proposed. In cases requiring specialized or unusual care, fees larger than the minimum are suggested.

A minimum dispensing fee of $5.00 for each pair of glasses dispensed is also suggested.

It is further suggested that all ophthalmic materials be dispensed to the patient at the prescription laboratory cost.

It is further suggested that the patient be presented with an individual itemized statement for professional fees, i.e., examination and refraction fee, minimum of $10.00 or more; plus dispensing fee of $5.00, if materials are dispensed.

In addition, it is suggested that all laboratory materials be collected for in full at the time the material is ordered, as this material is being dispensed to the patient at cost, and the optometrist should not, and cannot, carry any of these costs or charges on his open accounts.

The reader is referred to Part I of this report for the details of this proposal. (July, 1952, issue.)

start of a possible custom of collecting a dispensing fee for all services pertaining to adjusting and servicing frames. This, too, has been suggested by several optometrists and would, perhaps, answer the criticism of those who object to the idea of charging an original dispensing fee which covered subsequent frame adjustments.

Another point frequently mentioned in the correspondence is the $10.00 minimum examination and refraction fee. It must again be stressed that this suggested fee is just a *minimum* fee. The original proposal suggested that each optometrist make a study of his present practice and then select the proper minimum examination and refraction fee in relation to his current charges. As pointed out before by the writer, the minimum examination and refraction fee would work out, usually, at some figure between $10.00 and $20.00. No examination and refraction should, in the writer's judgment, be done for less than the minimum of $10.00 at any time by any optometrist. And to this must, of course, be added the dispensing fee of $5.00 if materials are prescribed.

This brings us to the interesting point raised by Borish. This had to do with a situation in a medium sized community in which the eye, ear, nose and throat men refracted for a $7.00 fee and dispensed their materials with the usual markup. Borish contends that optometrists in this city would require an enormous amount of self-confidence if they adopted the suggestions presented by the writer, as their examination and refraction fees would exceed those charged by their E. E. N. & T. contemporaries.

Well, so they would. But, why shouldn't they be higher? In general, professional fees vary from office to office in all the specialties, and as the patient would not be excessively charged by the optometrists under the suggested new fee structure plan, no harm is done. We must remember that it is far better to be known in an area as a man who commands substantial fees than it is to be known as a man with very low fees.

In addition, when the word got around that optometrists were following the new suggestions, it is reasonably certain that one or more of the E. E. N. & T. men would become interested and probably follow suit. Why not talk it over with them across the luncheon table? In any event, it seems to the writer that optometrists in this situation should *have* the self confidence to follow the plan. It must be remembered that it is in use in many places with considerable success.

Springer in his comments in Part III claims, "the materials consumed such as x-ray plates, dentures, legal manuscripts and abstract papers, etc., are not itemized as to cost. The public considers these things as necessary tools, so to speak, for the professional man to work with." This is not wholly the case. In large part it is true in dentistry. But, it is not true generally in medicine or law where the larger better run offices', clinics' and hospitals' itemized statements are presented for all actual and out of pocket costs which had to be supplied in relation to the professional work of the physician or lawyer. In many law offices even the actual postage spent while working on a case is kept track of and separately itemized on the final bill. In clinics and hospitals itemized bills are standard practice and these include a long list of items including blood transfusions, drugs, special therapies and the rental of equipment. The public is used to this practice and will accept it in optometry as it has elsewhere.

For a number of years, Barstow in his writings and lectures on economics has stressed the "chair-cost" approach in optometric practice. It has been a necessary study and was well presented. This cost is simply determined by dividing the annual overhead of the optometric office by the total number of patients served in a 12-month period. This chair-cost naturally varies, being highest in the offices of those optometrists with small practices and substantial overhead. It has been beneficial in optometry to have this information, as it materially assists in enabling the optometrist to have a realistic approach to his financial problems. This practice of determining chair-cost should be continued, and every optometrist should have his own data at hand. There is nothing conflicting about chair-cost and the suggestions on fees made by the author. In arranging the presentation of the suggested fee

schedule, it was necessary from the sociological aspect of our work to divide the subject in a different manner. The trend in all of the healing arts professions, including optometry, will be more and more to serve in programs which permit only the use of fees. For optometrists this will result in a fee for examining and refracting *and* a fee for dispensing. These fees may, and should, vary in individual practice, but in controlled programs of eye care, either private or public, they will not vary. Hence, the need for clear thinking along the lines of fees only. The relationship of these fees to the chair-cost of the individual practitioner should be kept in mind by him in setting his fees. Whether or not he wishes to cover his entire office overhead through his dispensing fee is up to him—although the writer doubts if in controlled programs of eye care a dispensing fee of more than $5.00 would be authorized. This subject will be more fully discussed in Part V of this report where the relationship between optometric fees and some of the national problems facing all professions in the Healing Arts will be reviewed.

Mote, in his comments, pointed out that there should be some latitude in the matter of an examination and refracting fee. In this the writer fully agrees. He believes the latitude should always be in the area above a minimum examination and refraction fee, below which the optometrist will not go. A minimum fee is just what its name implies. If your patients understand there is a minimum, and that in comparable refractive cases, all patients are treated alike, there will be no criticism. One cannot, however, have a sliding scale of minimum fees for the same type of work.

The question of referrals has also been raised. This is a matter touched on by several writers, and is a point apparently not too well understood by many optometrists. It is an item which has been discussed at various meetings of the National Interprofessional Committee on Eye Care, and is one which the optometrists and ophthalmologists on the committee are in complete accord. In referring a case in which pathology is suspected, or known to be present, the optometrist should fully complete the examination and refraction and send all findings to the ophthalmologist or physician to whom the case is referred. The findings should be accompanied by a request for a detailed report on the case from the ophthalmologist. Obviously, here a complete examination and refraction is required, and the optometrist's fee for this should be set accordingly. Patients expect this when consultations are in order.

In his discussions of the suggestions for a new fee structure, Wick observed that, perhaps, the $5.00 dispensing fee might be added to the cost of materials instead of being one of the two itemized charges

on the professional statement presented to the patient. The author finds that this thought frequently occurs to optometrists when they first review the proposal. It has been tried, but it will not work well, as experience shows that it quickly becomes confused with the charge for materials and soon loses its identity and becomes just an arbitrary markup on these materials. When the plan is used, experience shows, the dispensing fee must clearly retain its identity, and this is best done by keeping it a distinct part of the professional fees.

Several correspondents have claimed that the general level of all professional fees in California is substantially higher than elsewhere. If this is true, and the suggestions for a new fee structure are followed by optometrists on the Pacific coast, the minimum fees suggested by the writer would merely start at an appropriately higher plateau. Instead of concealing part of the professional fee in the markup on materials, optometrists universally should discontinue this practice and openly collect all of their fees in a straightforward manner. They will find there will be little or no difficulty in doing this as their patients have been paying these total charges anyway, and it has further been found that they appreciate a forthright understanding of the entire matter.

At present many patients feel that the markup on ophthalmic materials is excessive. These same patients will be found to be much more receptive to substantial professional fees as they are accustomed to these when served by specialists in other health fields.

Our correspondence also shows that a considerable number of older practitioners now indicate a marked sympathetic interest in the suggestions for a new fee structure and a willingness to study the application of these proposals in their own practice.

Younger practitioners, from their letters, are as a rule quite enthusiastic, and many have indicated that they already had, or will, try out the suggestions as outlined. Many are already doing so.

It is both interesting and significant to note that these suggestions of the writer in 1952 on fees have drawn far less criticism than did the more-or-less comparable proposals of Pine* in 1928 or those of Moore in 1947. While the proposals of both Pine and Moore were not similar to those of the writer, both men suggested substantial professional fees separated from the costs of materials. In the years mentioned, both Pine and Moore ran into marked and vigorous opposition on the part of so many optometrists that the promotion of the plans were dropped, and aside from occasional individual support, these proposals were subsequently ignored by the profession. This is not the case at this time.

*Lecture on optometric economics, Chicago, Ill., 1928.

Today, opposition, while evident, is by no means general, and the majority of optometrists who have written the author on the subject evidence a very sympathetic interest in the proposals and also an interest in the need for now giving the subject serious attention. This indicates again to the author the progress being made today in the profession and its attitude towards its work.

In the final portion of this report, Part V, the author will review the already known and recognized pressures which surround us as a professional group, and which make this fee study one of timely interest to all optometrists. Part V will appear in the November issue.

ANNOUNCEMENT

ACADEMY GEOGRAPHICAL ROSTER

The Executive Council of the American Academy of Optometry has authorized the publication of a geographical roster of all Academy members as of October 31, 1952: this date being the end of the fiscal year of the Academy.

This geographical roster will appear as a bound-in supplement to the November issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY: this issue being enlarged for this purpose. This geographical roster will serve two useful purposes. It will enable members to know each other better and to facilitate correspondence between members and it will also serve as a most useful guide in patient referral when patients move from one part of the country to another.

This roster will include a listing of our Canadian and overseas members and will also indicate those members who are Diplomates of the Contact Lens Section of the Academy.

If the publication of this geographical roster meets with the expected success predicted for it, the Executive Council plans to make this an annual addition to coming November issues of this publication.

THE OPTOMETRIST IN MILITARY PRACTICE*

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The position of optometry in the Armed Forces Medical Service seems to be of interest to all optometrists today. The position of optometry within the professional services and the status of the individual optometrist concerned is of particular interest to the young optometrist either now in service or who will soon enter the Armed Forces. For that reason, the following paragraphs contain a brief description of the optometry section of the eye clinic at this hospital.

Optometry along with pharmacy, psychology, bacteriology, and other numerically small professions has been grouped for administration only into what is known as the allied sciences, which, with the medical administrative officers, form the Army Medical Service Corps. This with the Medical Corps, Dental Corps, Army Nurse Corps, Women's Medical Specialists Corps, and Veterinary Corps forms the Army Medical Service. This has proved more practical than a separate optometry corps because of the difficulties and responsibilities in the administration of so small a unit in an organization so large as the United States Army. Optometry has assumed a respected position in the Medical Service Corps and is headed by a chief of the Optometry Section in Washington, D. C.

The individual optometrist in the Army has a great opportunity to provide the professional services for which he is trained. Patients are referred to the optometry section of this clinic from three principal sources:

1. Soldiers request a refraction and an appointment with the optometry section is made by the commanding officer of their unit.
2. They are referred by the medical officers from the dispensaries or clinics.
3. They are referred by the ophthalmology section for refraction or other services by the optometry section.

The optometry section of this clinic consists of two optometrists and two optical technicians. The technicians take the facial measurements of these individuals who receive glasses and adjust the glasses after they are fabricated. The optometrists are then permitted to devote

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their entire time to eye examinations and only supervise the dispensing of the spectacles.

The patient is first taken into one of the examining rooms where the refraction and such other tests as are necessary are done. Existence of pathology, amount and type of refractive error, and muscle balance are all determined and the patient is either released or other studies are done. On strabismus problems the investigation is continued and in certain other conditions an investigation of the visual fields is made. Sometimes the patient is referred to this clinic specifically for investigation of the visual fields and so we get considerable experience in taking both neurological and ophthalmological visual fields. Where it seems expedient, a homatropine refraction may be added to the other findings in consultation with the ophthalmology section.

Those patients needing further investigation are referred to the ophthalmology section and by the close association of the optometry and ophthalmology sections there is an opportunity for the complete study of a patient. In working with certain strabismics, for instance, we have the opportunity to examine and observe the condition before surgery, then observe the surgery and see exactly what is done to the muscle or muscles, and finally observing the patient following surgery. We also see certain types of ocular muscle imbalances in which visual training alone or with glasses will be effective and in this connection we undertake a limited amount of visual training in this clinic. The optometrists are often called in to see pathological conditions that are of special interest and by this close association we broaden our knowledge of ocular pathology.

When the optometrist deems it necessary to prescribe spectacles for Army personnel the proper facial measurements are made. The prescription for glasses is then forwarded to the Base Optical Shop, St. Louis Medical Depot, St. Louis, Missouri, where the glasses are fabricated using either a flesh, P-3, plastic frame or a 1/10-12K gold, P-3, frame or both. Those individuals going overseas receive two pairs, usually one in the plastic and one in metal frame, while those stationed in the United States receive two pairs only if they would be seriously handicapped during the period of repair. The fabricated spectacles are returned to this clinic for proper adjustment on the patient's face.

The interprofessional relations I have experienced in the Army have proved very educational to me. Our Chief of the Eye Clinic is a diplomate of the American Board of Ophthalmology. He is always ready and willing to discuss any patient or subject. Through these consultations we are encouraged to read the journals and textbooks in further

pursuit of information on refraction, physiological optics, orthoptics, pathology, etc., and thereby be better prepared to perform our work. The knowledge gained from this close association is immeasurable and I am sure it has made me a better optometrist and this pleasant experience will remain as a highlight in my optometric training.

The interprofessional experience I have had has been a great aid in teaching me what is expected of an optometrist when referring patients to another professional man. I believe the unfamiliarity with this procedure is a basis for some professional misunderstanding today and all optometrists would do well to consider this problem and strive for improvement.

The optometry officer has certain additional duties. These usually include having the responsibility of property, being a member of a Court-Martial, serving on fund councils, or being custodian of a fund. All Medical Service Corps officers are required to serve, on occasion, as Administrative Officer of the Day in which capacity they act for the Commanding Officer on administrative problems after normal duty hours. These additional duties seldom interfere with our professional duty, and I find some of my additional duties to be very interesting.

From the description of how the optometry section functions in this clinic, you can understand the advantage of close interprofessional cooperation. The advantage to all concerned in such cooperation is best explained in a recent statement by Derrick T. Vail, M.D., noted ophthalmologist: ". . . It has been demonstrated in the Army and Navy that optometrists and ophthalmologists can work side by side peacefully for their advantage and to the advantage of the patient as well."

The military optometrist is furnished excellent equipment and materials to perform his professional service. In performing this service he is presented the opportunity to join a professional team dedicated to the conservation of vision in the Armed Forces and his part on this team can prove to be of tremendous value to himself and to the profession of optometry.

ABSTRACTS

THE NONSURGICAL TREATMENT OF CATARACT. R. F. Shropshire and Jacob R. Ginsberg. Science. Vol. 116. Number 3011. pp. 276-278. 1952.

Shropshire and Ginsberg review a series of experiments made first upon animals and later upon adult human patients suffering from cataract. Injections of fish lens protein were used and in a group of 12 patients reported upon in detail by the authors, all patients had marked improvement in visual acuity over a six-month treatment period. Not only did visual acuity improve but the lenticular opacities as shown by ophthalmoscopic photographs were much less pronounced. A larger group of patients is now under investigation and will be reported on at a future time.

C. C. K.

COLOR VISION DIFFERENCES IN THE TWO EYES OF A GIVEN INDIVIDUAL*

A CASE OF SIMULATED UNILATERAL ATYPICAL ACHROMATOPSIA

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INTRODUCTION

The incidence of unilateral color blindness would seem to be extremely low. Judd[1] lists thirty-seven cases found in the literature dating back to 1858, but points out that the actual number may be much higher since color vision is normally tested binocularly. As a result of this practice the normal result is to detect the extent of defect in the better eye. Although this fact has been realized for many years, no investigation has been reported in which a survey has been made of a large population in order to determine the percentage of unilateral color defects.

Miles and Beaumont[2] estimated that the incidence of unilateral defects is about four per cent of the total color defectives. This estimate was based on finding two cases in a total of fifty-three cases of color defectives studied. There are no known accounts of the incidence of unilateral defects among so called "normal" individuals.

The study of unilateral color defective individuals may offer valuable information regarding the nature of color vision. It may lead us to better understand why color-blindness tests sometimes fail and so be in a better position to develop improved tests. Also the color deficient observer may better understand his color confusions and be aided to avoid their consequences. Such a study was begun when a case of unilateral atypical achromatopsia (achromatopsia with normal central acuity) was reported in our clinic. Since only seven typical cases are reported in Judd's listing of thirty-two unilateral defectives—everything was dropped to study this atypical case.

CASE REPORT

Subject: B. S. (Male)

Age: 15 years (born May 24, 1936)

History: About four years ago a blow was received on the nasal side of the left orbit with a baseball bat. While the eye was still swollen

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†Optometrist, Ph.D. Member of faculty. Fellow, American Academy of Optometry.

and black and blue from the blow, stained histological slides were being examined in biology class. The colors described by the teacher were not visible to the subject when he looked into the microscope with his left eye. This was reported to his grandparents who dismissed this "story" and nothing further came of the matter. These events occurred in Kansas City, Missouri.

About March, 1951 the subject came to Los Angeles to live with his mother and stepfather. He reported his left eye color blindness to his parents who in turn discussed his condition with one of our clinical instructors.

The parents are both commercial photographers and the boy is interested in photography and radio. He is a bright youngster, nonchalant in his manner and was at all times very cooperative.

He has been under medical care during the period of our tests. He has not been permitted to take physical education in his school work because of high blood pressure and there is a possibility that he has a kidney ailment. His mother sent him to a psychiatrist who has not been able to make a complete diagnosis because the results of his physical examination are not yet complete. The cutaneous sensations of heat and pain are absent in his limbs. Body and head are normal in this respect. He reports that he can feel pain when he is burned on the foot without his knowledge (as in being given a hot foot). He does not seem to mind talking about his ailments, nor does his mother.

There are no known cases of color blindness in the family. The only anomalies reported are quadrant type heterochromidia in the mother's brother and paternal grandmother

Examination: April 2, 1951 (R. D. Wootten, O.D.)

Uncorrected Acuity: 20/15 O.S., O.D., 20/20 O.U.
Fundi: Normal.
Subjective: O.D. Plano O.S. Plano —0.25 X 170.
Acuity: 20/15 O.U., O.S., O.D.
Phorias and Ductions: Normal.
Amplitude of Accommodation and Convergence: Normal.

April 13, 1951 (the author)

Fundi: Normal.
Pupillary Light Reflexes: Normal.
Pupillary Accommodation and Convergence Reflexes: Normal.
Perimetry: Blind spots normal, white fields normal.
Pseudo isochromatic plates:
Ishihara
American Optical Pseudo-Isochromatic (Revised Selection)

Stilling

O.D.—all responses normal.

O.S.—no figures or numerals read. Malingering plates read only after prodding.

This last finding, in addition to cooling the author's enthusiasm, led to the conclusion that further special tests were needed.

It was obvious that it was necessary to devise a test in which the subject would not know which eye was seeing the stimulus. Two such tests were devised.

The apparatus used in the first test was the stereo-campimeter. In place of the usual grid, a flat black surface was presented on the easel. Tangent screen targets were used as the color stimuli. Four were chosen —white, blue, green and red. The experimenter stood facing the observer and the instrument. It was possible for him to quickly slide the target straight down the easel in front of either eye and then remove it quickly, being careful not to actually touch the surface. When done properly it was not possible for several observers to tell which eye was seeing the target. By presenting the colors to one eye at a time in random order it was felt that the color response could be elicited if the subject were simulating color blindness.

On November 17, 1951, the subject was submitted to the above described test. The first target presented was the blue disc and it was shown to the left eye (the defective one). The subject's response was an immediate "blue!" The rest of the stimuli were presented and it soon became apparent that the subject was catching on. His responses became hesitant—at first only when the target was presented to the left eye, later also when the target was presented to the right eye. The test was considered invalid since the subject admitted that he knew which eye saw the target. This was demonstrated by using the white target only and asking which eye was seeing the target. At each trial he named the correct eye. When asked how he knew which eye was seeing the target he replied that it felt just as though we had touched his eye.

The second test consisted of making a direct binocular match of two halves of a maxwellian field. Two images of a single light source were focused on his pupils by means of a bicentric lens. The right eye saw the left half of the field and the left eye saw the right half of the field. This crossed relationship was intentional. Colored Wratten filters were used in the beam to present in turn red, blue, blue green, and yellow stimuli. Neutral density filters were used in conjunction with the colored filters to approximately equate the luminances.

The maxwellian field test was given immediately following the campimeter tests. In each case the left half of the field was described as grey and the right half as having the correct hue—exactly opposite of

what should have been reported. He had assumed that there should be a direct correspondence between his left eye and the left field and between his right eye and the right field. Both eyes were in full view of the experimenter at all times and he made no attempt to blink his eyes alternately as if testing the situation. In all tests he was completely calm and answered all questions carefully and slowly. The fact that his answers were reversed was not mentioned.

The subject was next asked to describe what he saw in a spectroscope. The spectral colors were described as expected when seen with his right eye, but with his left eye the entire spectrum appeared grey. The brightest portion of the spectrum corresponded with the yellow-orange region which would roughly indicate a photopic response since the source used was a tungsten incandescent lamp. The high percentage of red in this source would shift the maximum in that direction.

At the next examination on November 29, a crossed polaroid test situation was used. Out of focus colored patches of light were projected through a sheet of polaroid on a non-depolarizing screen viewed at about two meters. The colored patches were projected by means of a conventional two by two inch slide projector. The color slides consisted of a Wratten filter and a mask sandwiched between two pieces of glass. The black mask had a hole punched in it about one-fourth of an inch in diameter. The filters used were red, yellow-green, blue and neutral density. Again neutral density filters were combined with the colored filter to approximately equate luminances.

The patches of light were observed in a partly illuminated room through polaroid goggles which had the axes of polarization ninety degrees apart for the two eyes. The polaroid screen through which the patches were projected could be rotated so that only one eye would see the flash. The patch was projected for a tenth of a second.

The subject was permitted to see the four colors binocularly and was asked to respond by naming one of the four colors in the test to be performed, even if he had to guess. The goggles were then given to him to put on and he was told that they were to be used to reduce the intensity of the light. Sixteen flashes were presented, each color appearing twice for each eye. Every stimulus was named correctly.

At the conclusion of this test the subject was told that he had seen half the colors with his left eye. He replied that he was aware that he was seeing the flashes with one eye only, but was not able to tell with which one. He admitted that he was as puzzled as the experimenter. He asked later whether his color defect might be psychological. He was told that that might be a possibility, but that such a case had never been reported.

A further test was attempted using the crossed polaroids. The

rotating polaroid was set so that only his left eye could see the flash. He was told that this was the case. When the colors were flashed he was able to name each color correctly. He was next instructed to hold his hand in front of his right eye and the colors were again presented. Now he reported that all of them appeared grey. Upon uncovering his eye he could again see the colors.

He knew that in either situation he was seeing the flash only with his left eye and yet when both eyes were uncovered he saw the color of the patch. As soon as the right eye was covered—the left eye became color blind.

Immediately following these tests Dr. Schapero of our college took the subject to the fields room for fatigue field measurements. The 180, 0, 270, and 90 degree meridians were measured centripetally in that order. Each limit was determined six times. The left eye was measured first. The first round of readings was normal (95°, 55°, 75°, 45° respectively), but with each successive measurement the field contracted. The final readings showed that the field was roughly 30° in each of the four meridians (35°, 30°, 23°, 23°). The field of the right eye was tested immediately and found to be normal and remained normal through six series of readings. The left eye thus exhibited the contracting fatigue field described in neurasthenia whereas the right eye field was normal.

SUMMARY

A fifteen year old boy has been examined whose visual functions are normal in all respects except one. His left eye is totally color blind when tested monocularly. Special tests have revealed that he is able to differentiate white, blue, green, and red with this eye whenever these stimuli are presented in such a manner that he is unable to tell which eye is seeing the stimulus. It would appear that he is totally color blind whenever he thinks that he is seeing monocularly with his left eye.

The spectrum appears entirely grey to his left eye. The position of the brightest portion of the spectrum seems to indicate that the response of the defective eye is essentially photopic.

Further tests are being undertaken to determine the luminosity functions of the two eyes.

The fatigue field of the right eye was shown to be normal. The left eye exhibited the contracting fatigue field described in neurasthenia. This finding would tend to eliminate malingering as a factor in this case. The subject's cooperation and demonstrated interest in his defect would lend weight to this conclusion.[3]

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ACTIVITIES OF INDEPENDENT ORTHOPTIC TECHNICIANS

In 1938 the American Orthoptic Council was formed by representatives of ophthalmological societies and sections. This Council had for its objectives the stimulation of interest and research in orthoptics among ophthalmologists and the training of a group of orthoptic technicians to assist ophthalmologists in doing their orthoptic work.

The Council has been active during the ensuing years and has aroused among some ophthalmologists at least. an interest in orthoptic procedures and an appreciation of their value. Prior to the Council's inception, this interest was at a rather low ebb among ophthalmologists generally.

Several training centers were set up by the Council and a number of young women have taken courses leading to certification as orthoptic technicians. It is estimated that at present about 150 of these are employed in the offices or clinics of ophthalmologists in various parts of the country. Here these orthoptic technicians work under the immediate personal supervision of the physician. They assist in giving orthoptic treatments or visual training periods to patients of the ophthalmologist who require this help. Under this arrangement, it is the ophthalmologist who makes the diagnosis and who outlines and supervises the course of treatment to be followed by the technician.

During this same period there has also been an upsurge of interest in orthoptic work among optometrists and the Section on Orthoptics of the American Academy of Optometry has been most active in eliminating many of the misconceptions which surrounded this work in optometric circles in prior years. Optometrists, too, have, as individuals, personally trained many office assistants to do this work under their personal supervision. In optometry, too, special courses have been arranged for these optometric orthoptic technicians at a number of optometric extension program meetings.

From the foregoing it is evident that in a large practice, either optometrical or ophthalmological, where much orthoptic work is attempted, some specialized trained help is required to enable either the optometrist or ophthalmologist to utilize his office hours to the greatest advantage.

This help is now recruited, in optometry, through the ranks of individually trained office assistants and, in ophthalmology, through the same method or by the employment of technicians certified by the American Orthoptic Council. In either event, these young women work under the direct and constant supervision of their employers and, when properly trained, serve a most useful purpose to both the doctor and the patient.

Now, something different, and a little confusing, has crept into this practice of using technicians. During the past several years there has been evidence that a small number of certified orthoptic technicians have opened their own offices and accept patients for orthoptic training on referral only from ophthalmologists. This practice is not wide spread, and we know of no optometrically trained orthoptist who has attempted to practice on her own. We may be sure, however, that the optometrically trained orthoptists are watching this new development on the part of their sister orthoptists with considerable interest and, if the latter are able to establish individual practices, it is only a matter of time before the orthoptists trained in optometry will follow suit.

Whether the American Orthoptic Council can, or will, police this problem remains to be seen. We hope they will. The writer understands that young women certified as orthoptic technicians by the Council have agreed, as a condition of their certification, to work only under the direct supervision of an ophthalmologist. Whether this agreement can now be stretched to include an independent orthoptic practice on referred cases in an office removed from all direct and intimate supervision remains to be seen. The writer believes it cannot and should not be so construed by the American Orthoptic Council.

An important question, affecting all public health activities, is presented in this new development.

If orthoptic work can be delegated to the outside technicians through patient referral, then almost any type of health work can also be delegated. The use of technicians under proper personal supervision is one thing. The technician setting herself up as an independent entity within the overall health picture is another. As these young women are supervised by a responsible medical group, it seems that the first step in rectifying this problem is up to this group. In good faith, the American Orthoptic Council is charged with the responsibility of getting all of its certified orthoptic technicians back under the direct supervision of ophthalmologists in their offices and clinics where these technicians belong.

CAREL C. KOCH

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ACADEMY TO MEET AT ROCHESTER

Optometric history will repeat itself in a most unique and interesting way at the coming Academy convention in Rochester, New York, in December. In keeping with the historical theme of Bausch & Lomb's 100th anniversary, Dr. Meredith Morgan's program and papers committee has planned an historical feature which will bring poignant memories for older Academy Fellows and give new members a glimpse of an important segment of optometric history.

Early in 1952, Dr. Morgan's committee selected five scientific papers which they considered among the most significant heard by the Academy between 1928 and 1940. They then contacted the authors of these papers and asked them if they would add current new material

and again present their papers to Academy Fellows at Rochester. The authors all agreed to the plan.

The five papers chosen by the program committee are as follows. They will be remembered not only by Academy members but by readers of the *American Journal of Optometry*, as all the papers were originally published in the Journal.

Dr. Charles Sheard's, "Zones of Ocular Comfort."

Dr. Julius Neumueller's, "The Resultant Correction Cylinder of Combined Corneal Astigmatism at Oblique Axis and Physiological Astigmatic Allowance."

Dr. Glenn Fry's, "Experimental Analysis of the Accommodative-Convergence Relations"—a summary of all experimental work done at Ohio State to date.

Dr. Edwin F. Tait's, "Quantitative System of Dynamic Skiametry."

Dr. Howard Haines', "Normal Values of Visual Functions and Their Application in Case Analysis."

The program and papers committee has definitely received word that Dr. Fry, Dr. Sheard and Dr. Neumueller will present their papers in person. Dr. Tait and Dr. Haines are unable to be in Rochester, and their papers will be read for them. Dr. Kenneth Zinnecker who will work with Dr. Haines on the modern developments of his subject will read the paper for Dr. Haines who is now in military service.

The profession was built to some extent on the concepts covered in the above papers. The concepts are still fundamental to the practice of optometry. Their re-reading will bring back not only a review of early fundamentals, but will show what optometry was thinking scientifically back in the days when the trend in specialization was just beginning, and the Academy had less than 200 members. To hear these same men who pioneered in scientific research re-read their own papers plus their continued research on new developments in the field will be a thrill no Academy member should miss. Hearing those papers alone would justify the trip to Rochester.

The program committee has, however, much more in store for Fellows going to Rochester. In addition to the historical papers, the following men will present papers on various optometric topics: Drs. William Schumann, Max Schapero, Monroe Hirsch, Merrill Allen, Elwin Marg, George Knox, Eugene Freeman, Mathew Alpern, Joseph Pascal, Israel Dvorine, Frank Dickinson, Isidore Finkelstein, Henry Knoll, Vincent Ellerbrock, Robert Bannon, Sidney Haniford, Harry Jankiewicz, Henry Frank, Armand Messier, Richard Feinberg and Helen Robinson.

These speakers will cover ocular pathology, orthoptics, industrial vision, contact lenses, aniseikonia, and problems of refraction. Their topics will be announced in November, at which time a complete program of the Rochester meeting will be published.

Academy Fellows should be convinced from this program preview that the Rochester meeting looks like the most interesting to date—and that's always a big statement, for there have been superb programs in the past—but none with the special historical feature planned by the program committee, and none when Bausch & Lomb was celebrating its coming anniversary.

Make your reservation now. The convention will headquarter at the Seneca Hotel, Rochester, New York. The dates: December 6, 7, 8 and 9, 1952. Registration for the convention will be at 8:30 a. m., on Saturday, December 6.

VIRGINIA HUCK

LOCAL CHAPTER ACTIVITIES

IOWA CHAPTER

An exceptionally varied and comprehensive program has been planned for the Fall educational meeting of the Iowa Chapter. Dr. Otis D. Wolfe (M.D.) will speak on glaucoma: Dr. Russell M. Wolfe (M.D.) on motility; Drs. R. C. Shiller and Henry L. Wolfe on aphakic prescriptions and problems with patients, at the first day's session. Dinner on Sunday evening will feature a short talk on "What is Expected of New Graduates," by the chapter president. On the second day, Dr. Dale Harris (M.D.) will discuss the relation of diabetes to eyes, and Dr. Otis Wolfe on juvenile cataract. This meeting is scheduled for November 30 and December 1 in Marshalltown.

SOUTHERN CALIFORNIA

Drs. Marian and Robert Eakin, specialists in orthoptics, lectured on "Differential Diagnosis Applied to the Practice of Orthoptics," at the first Fall meeting of the Southern California Chapter.

NEW YORK ACADEMY

A joint meeting of the New York and New Jersey Chapters of the American Academy of Optometry was held in September at Newark, New Jersey. Addressing the joint session was Sigmund Schutz, M.D., Clinical Professor of Ophthalmology, Polyclinic Hospital. His topic was Systemic Ophthalmology.

CURRENT COMMENTS

Virginia Huck
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department: such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

A MATTER OF SUPERVISION

Even a good idea can get out of hand, it seems, and it now looks as though a good one relating to visual care is on the "out-of-hand" track. In reading a leading women's magazine lately we noticed their job-of-the-month department, which evaluates job possibilities for America's young women, featured the work of the orthoptist.

The orthoptist, the article explains, "teaches eye exercises to patients —mostly children—who have poor muscular control or crossed eyes. A nursing degree, or some college training in science, is desirable background. A nine months training course and a written practical examination given by the American Orthoptic Council are required for certification in the field."

The article concludes, "An orthoptist may work in a hospital clinic or for a private group of doctors, *or even set up her own office.*" (Italics, our own.)

This last phrase indicates that it is acceptable, to some at least, for an orthoptist so certified to practice away from medical or optometric supervision. We wonder, as does Editor Koch in this month's editorial, whether the orthoptist idea is getting out of hand, and feel it is time to give some thought to the question. Apparently, judging from the *Glamour* article, the idea of practicing away from supervision has already gained some acceptance.

A SUCCESSFUL IDEA

As is often the case, news of the military services is sometimes slow in getting to civilians. Only recently did we hear about the story of the unusual work done by Dr. Lester Zeff, Wierton, West Virginia optometrist, while serving as an optometrist at Randolph Air Force Base, Randolph Field, Texas, although he has been separated from the service for several weeks.

While at the Eye Clinic of Randolph's base hospital, Dr. Zeff had an idea for greatly improving the efficiency of bombardiers wearing glasses. The idea was stimulated by the problem of a civilian employee at the airfield's bombsight maintenance shop. Because he wore glasses, the employee couldn't properly focus the bombsight eyepiece to calibrate

it correctly. Dr. Zeff figured that since the bombsight eyepiece contained a lens suited to perfect eyesight, it would be easy to substitute an eyepiece lens corrected to individual prescriptions, and do away with glasses while operating the mechanism. The idea worked for the employee of the maintenance shop, and eventually special eyepiece lenses also were prescribed where needed for Randolph Field bombardiers on B-29's. The question immediately pops up—how does it happen that bombardiers are wearing glasses? Dr. Zeff explains that these men are recalled reservists trained as bombardiers in World War II. During their war service they needed no glasses, but now, years later, need corrections.

The specially prescribed removable eyepiece lenses for the bombsights has improved efficiency as much as 50 per cent. The idea works for navigators too, in their sextants. The lenses can be carried by military personnel from base to base, and continent to continent, and are therefore both economical and practical. Some military men feel Dr. Zeff's idea could eventually result in the acceptance of men needing glasses for combat duty, in the event of a military manpower shortage.

FIVE AFTERNOON AND EVENING SESSIONS

The Minneapolis District Optometric Society, a group of about 70 metropolitan practitioners, will pioneer in 1952-53 with a new kind of program for a district society, which it feels will stimulate an always needed interest in postgraduate study.

Operating on the theory of an old proverb, the Society is going to bring college to the practitioners, inasmuch as the practitioners can't always get to college for postgraduate study. Five members of the faculty of Chicago College of Optometry have been engaged to lecture before the Society and present an integrated study course over a period of five months, covering essential phases of optometric practice. On November 12, Dr. Erich Fantl (M.D.) will lecture on pathology and neurology; December 10, Dr. David Michaels, on physiologic optics; Dr. Z. J. B. Schoen on January 14, 1953 on graphic analysis; on February 11, 1953, Leo S. Stein, C. P. A., on optometric economics and tax accounting, and on March 11, 1953, Dr. Leo Manas will talk on an O. E. P. Analysis.

These professors will work together to present to Minneapolis Society members a continuous course of study they could get otherwise only by taking the work at the college.

Dr. Donald Anderson, Society president, feels that if this program is successful this year, it could be repeated next year with different faculty members undertaking the lecturing. In this way, practitioners who cannot get away from their practices can keep up to date. The Society Execu-

tive Committee is in charge of planning this unique educational program, and all Minnesota optometrists are invited to participate.

NEWS BRIEFS

The University of California School of Optometry recently made the following promotions in academic rank for faculty members: Gordon L. Walls, promoted to professor of physiological optics and optometry; Owen C. Dickson, to associate clinical professor of ophthalmology; Merton E. Flom and Frank V. Johnson, to clinical instructors in optometry. . . . The Association of Independent Optical Wholesalers meets November 12-15 at the Bismarck Hotel in Chicago for its annual meeting and manufacturers' day. Dr. James Wahl, A. O. A. president, will be one of the speakers. . . . Dr. Joseph I. Pascal has been appointed lecturer in ophthalmology at the Brooklyn Eye and Ear Hospital, New York. The appointment is in addition to his other lecturing activities at the New York Polyclinic Medical School and Hospital and the New York Eye and Ear Infirmary. . . . Dr. Conrad Berens, executive eye surgeon of the New York Eye and Ear Infirmary, will be one of the speakers at the coming Second Annual Rutgers Occupational Vision Conference in Atlantic City, November 13 and 14. Thirteen groups are co-sponsoring the conference, including the National Society for the Prevention of Blindness and the New Jersey Optometric Association. . . . The American Optometric Association has recently published the Fourth Edition of its monograph on "Optometry," covering the question, "What is Optometry," and the development of the profession. The booklet brings up to date a discussion of problems of interest to all practitioners—need for O.D.'s, educational requirements, cost of living, fees, ethics, etc. The newly revised monograph was prepared by the Department of Public Information.

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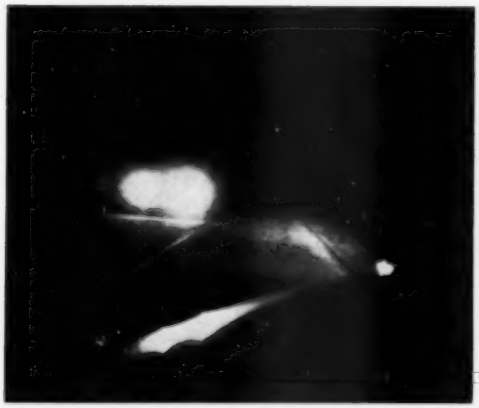

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